The CORNELL ENGINEER

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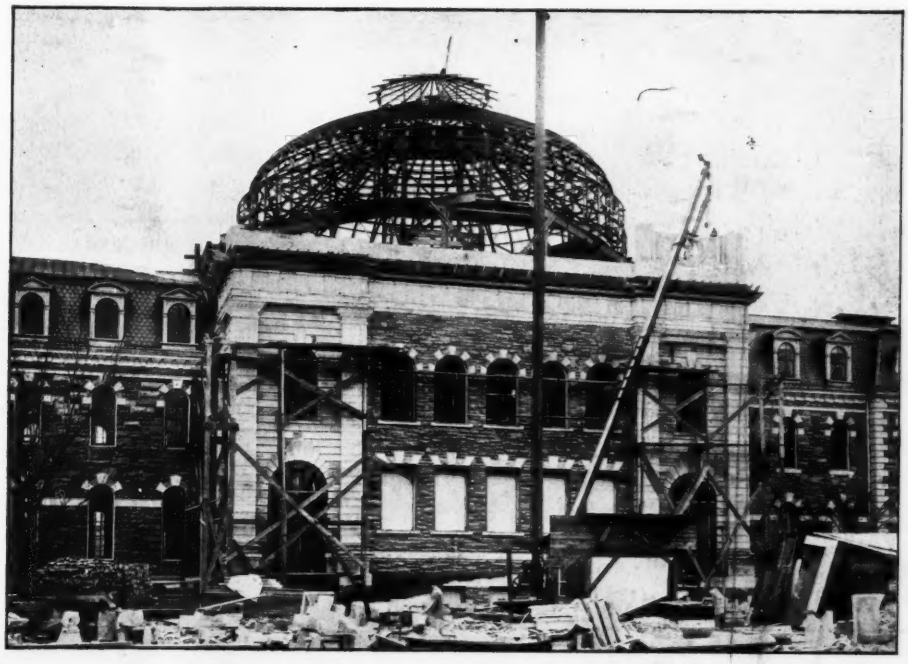


In This Issue:

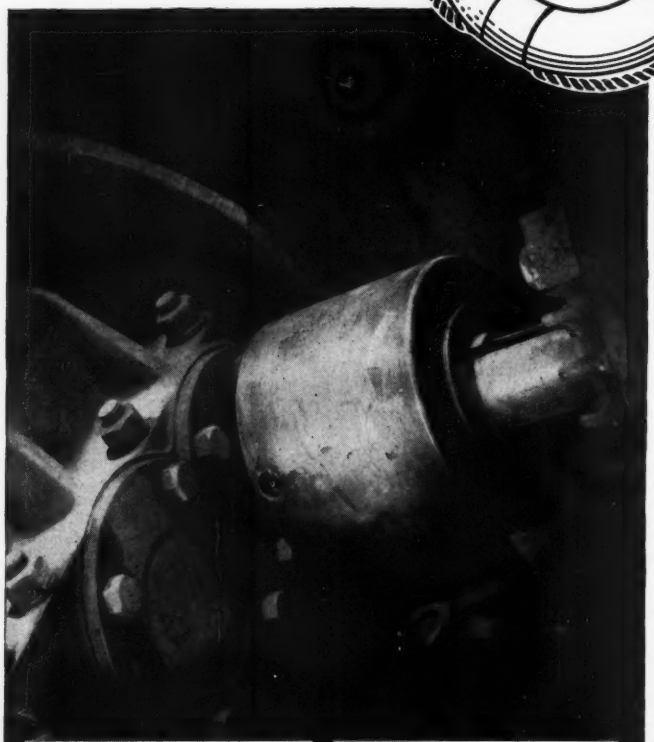
The PIONEERS of the COLLEGE of ENGINEERING

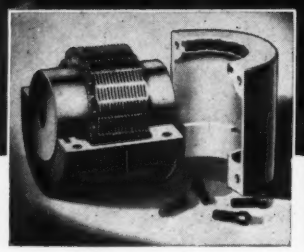
By Dean-Emeritus Dexter S. Kimball

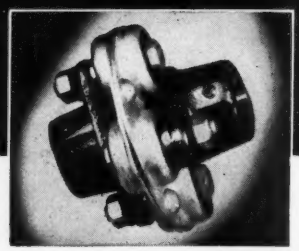
Volume 2 MAY - JUNE, 1937 Number 8 - 9

"POWER-PLANT Life Savers"

that's what you will call MORSE COUPLINGS







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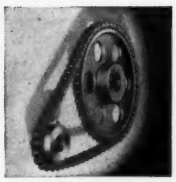
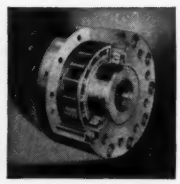


Morse Roller Chains

Morse Silent Chains



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WORN SCREW-CONVEYOR flights rebuilt by bronze-welding save replacement costs.

Build up the worn down . . .

Previous habits in the metals field reversed by new welding technique

UNTIL a comparatively short time ago, when metal parts were worn below the limit of tolerance, they were discarded. Further cutting down could not make them fit the job again. This method wasted both time and money.

With the introduction of welding, this picture has been entirely changed. It is easy now to build up metal at low cost. Parts, worn too small to be useful, can be returned to original size and shape. By the oxy-acetylene welding process, new metal is put on where the old has been worn away. The original investment may thus be salvaged by a small additional investment in repair by welding.

Welding Means Low-Cost Repairs

Welding has made rapid strides in the repair and rebuilding of worn parts. In every industry where metal is used and wear occurs, welding methods are saving money. Oil-well drills can now be kept in cutting shape long after their normal life span is past. Railroad shops repair and rebuild worn parts of rolling stock and track by welding as a regular procedure. Factory tools and machinery are kept in shape through welding as one of the surest ways to low-cost, profitable operation. Contractors and engineers rely on welding to rebuild worn drill bits, picks, shafting and wearing parts on shovels and digging equipment. The list of repairs made by welding is growing rapidly.

A Friend in Need

Welding is indeed a friend in need. For example, when work is being done on time contracts, it is of vital importance that worn or damaged equipment can be repaired quickly on the job. Suspension of operations until new parts could be obtained would be fatal to speed and profit. With welding, such interruptions are prevented since machinery and equipment are kept continually in operating trim. The scrap piles are kept at a low ebb. Worn metal parts, from shovel dipper teeth to truck axles, are reclaimed by welding. It can be depended upon to give satisfactory results in repair, maintenance and fabrication.

$2,000 budgeted for new saws was saved by welding. Before any money was spent, the company checked into the possibilities of welding. Saw-repair by welding was developed, and now saws with broken teeth, cracks or other damage are restored at a fraction of the cost of new saws.

* * *

Welding of the copper kettles used for boiling wax in chemical and dye manufacture has become a regular routine that saves a chemical company many hundreds of dollars. After being in service for some time, the bottoms of these kettles become very thin. As the kettles have both an inner and outer shell, it was found best to weld in two new bottoms.

* * *

Welding was used by a midwestern creamery to rebuild the teeth on a large gear. The gear was worth $600, and the rebuilding work cost less than $50. This one job alone far more than paid for all necessary welding equipment.

* * *

Welding saves thousands of dollars each year for a large western railroad. Battered rail ends, caused by constant hammering of the car wheels at the joints, are rebuilt by welding. The rail ends are welded in place without traffic interruption. This saves taking up the rails, sawing off the ends, redrilling and relaying.

* * *

Welding is used to reclaim worn and broken reamers from automobile shops. The reamers, which cost from $2.50 to $16 each, reclaimed by welding are as good as new, at an average cost of 40 cents. Breakage and loss of teeth on this type of tool are extremely high. The tooth bill in these shops has shown a healthy reduction since welding methods have been used.

* * *

In a wood-products mill, welding is used to rebuild the steel shafts in pulp grinders. These shafts, originally a foot in diameter, wear rapidly and continually at the collars holding the stone. A small amount of play makes it difficult to keep the collars drawn up tight. Under these conditions, wear happens fast. Common practice, before the advent of welding, was to change the collars and bearing four to eight times as the shaft wore down and was remachined. When the shaft was too small, about eight inches in diameter, it was discarded. Now by welding, the shaft is built up to original size as soon as it wears. Many thousands of dollars in new shafts, collars and bearings are saved annually.

* * *

Tomorrow's engineers will be expected to know how to take advantage of this modern metalworking process. Many valuable booklets describing the oxy-acetylene process are available without obligation. For further information write any Linde office.

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THE CORNELL ENGINEER

PUBLISHED MONTHLY DURING THE COLLEGE YEAR

Volume 2 | MAY - JUNE, 1937 | Number 8 - 9

COMMENTS

Former Dean Kimball offers us an accurate and concise account of the beginnings of engineering at Cornell. Cornell's past is related by one of her great "Pioneers of the College of Engineering."

* * *

Professor Mackey gives a valuable discussion of refrigeration and reveals modern methods of utilization of water vapor for cooling in his article "Refrigeration With Water Vapor."

* * *

The visit to the Buffalo Sewer Project and the Bethlehem Steel Plant in Lackawanna made by the Civils is described in the article on the "Buffalo Inspection Trip."

* * *

We present the "Reading List for Junior Engineers" by special permission of the Engineering Council for Professional Development.

CONTENTS

Construction of Sibley Dome ..... Cover

Robert Henry Thurston ..... Frontispiece

The Pioneers of the College of Engineering 177
Dean Emeritus-Dexter S. Kimball

Refrigeration With Water Vapor 180
C. O. Mackey, M.E. '26

Buffalo Inspection Trip 184
G. J. Kaye, C.E. '38

Reading List for Junior Engineers 186

Editorials 188

Do You Know These Men? 189

College Notes 190

President's Column 192

Alumni Notes 198

Stress and Strain 199

Index for Volume 2 200

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ROBERT HENRY THURSTON
DIRECTOR
1885 1903

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Volume II | May-June, 1937 | No. 8, 9

The Pioneers of the College of Engineering

By Dexter S. Kimball

Dean-Emeritus of College of Engineering, Cornell University

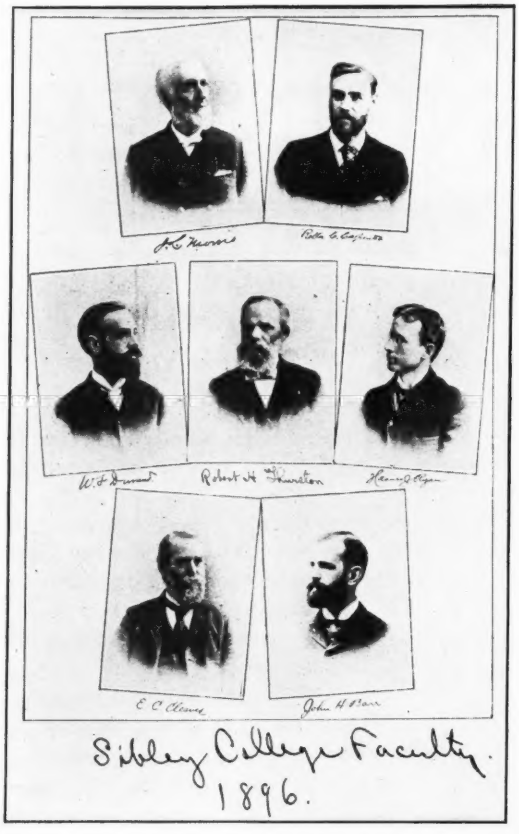
The editor's request that I write a brief account of the men who laid the foundations of engineering at Cornell is not an easy one to fulfill. Engineering at Cornell is the lengthened shadow of many men and in a short article it is possible only to write of those who cast the longest shadows; but it should be remembered that many men young and old have contributed to its curriculum and have helped guide its development. Cornell, being a "Land Grant College", naturally established engineering and agriculture as integral parts of its foundation. When Cornell opened its doors in 1868, civil engineering was fairly well established as an applied science, but mechanical engineering was still quite empirical and electrical engineering was yet to be born. The first announcement of the University lists a College of Mathematics and Engineering (consisting of a School of Mathematics and a School of Civil Engineering) and a College of Mechanic Arts. The faculty of the College of Mathematics and Engineering consisted of Dean E. W. Evans and Professors Cleveland, Morris, and Potter. The faculty of the College of Mechanic Arts consisted of Dean E. W. Blake and Professors W. C. Cleveland, Evans, and Morris. There are probably very few graduates who remember any of these men with the exception of "Johnnie" Morris, whose memory is still green in the recollections of many Cornellians. There is an excellent bust of Professor Morris in the Sibley Library. It was the task of these men to interpret the Morrill Act, and considering the empirical character of mechanical engineering at that time they made a good diagnosis of the problem.

The Register for 1871 lists the College of Civil Engineering and Architecture, the College of Mathematics and the Sibley College of Mechanic Arts, with Dean Cleveland at the head of the first, and Dean John L. Morris at the head of the last college, for which Mr. Hiram Sibley had built and endowed the building now known at West Sibley. The name of the Reverend Charles Babcock also appears as Professor of Architecture on both faculties. Professor Babcock built and lived in the house now occupied by the Dean of Women across from Sage Chapel. He also designed the Old Armory, Sage College, Sage Chapel, Franklin and Lincoln Halls.

Architecture appeared as a separate college in 1897 though it continued to occupy the upper floor of Lincoln Hall until 1906, when it was moved to its present location. After the establishment of Sibley College, the two colleges of engineering diverged into independent units with entirely distinct faculties.

In 1875 Estevan A. Fuertes joined the faculty of Civil Engineering and ten years later he became Dean of the Faculty. He was the first of an interesting and distinguished group of teachers who made civil engineering at Cornell famous. That same year Charles Lee Crandall was appointed as Assistant Professor. In 1877, I. P. Church was appointed as Assistant Professor. Charles D. Marx, afterwards famous for his work as a pioneer at Stanford University, appears in 1884. Henry S. Jacoby joined the group in 1890 and the name of Henry N. Ogden appears among them in 1896.

What manner of men were these Pioneers? Fuertes, a Porto Rican by birth, was an explosive sort of a man, something of a dictator, who won for himself the title of the "Great Mogul" or more familiarly and affectionately, "The Old Mogue", and many interesting stories cluster around his memory. The painting of the Mogul in the Director's office is a perfect likeness. Yet he was a man of high ideals who believed firmly in the dignity of his profession, and those who worked with him hold kindly memories of him. Crandall was a mild mannered man of a practical turn of mind and much beloved by the students, especially those who had gone on surveying parties with him. Professor Church, a smallish, scholarly man, was a remarkably fine teacher. Furthermore his text book on Mechanics was a land mark in college books. Through this book and the many teachers he trained, Church exerted a great influence on engineering education and his work did much to attract attention to the college. Charles Marx did not remain very long at Cornell, and, as noted, he became famous as an educator else-

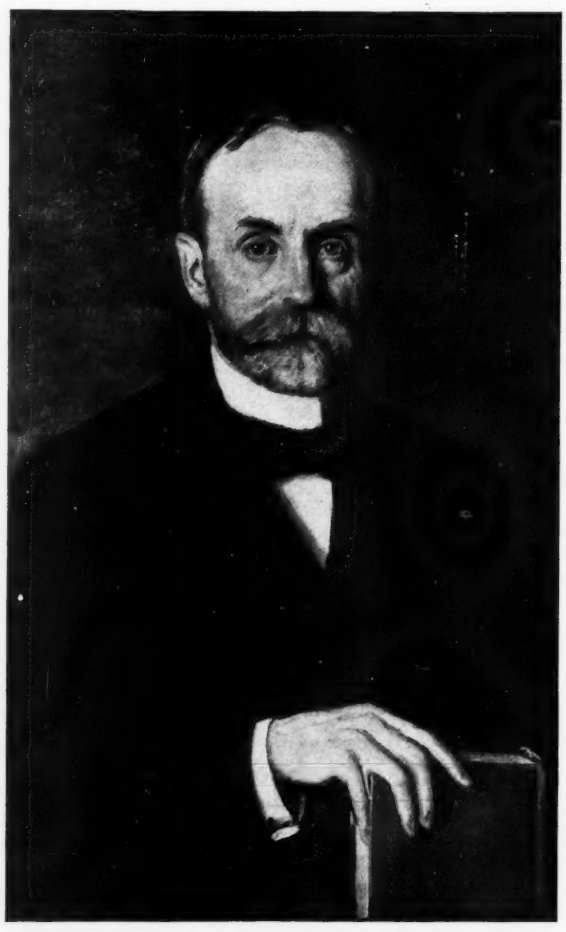


where. At 80 years of age he now makes his home in Palo Alto, California. Professor Jacoby, who was 80 years old on April 8, and who now resides in Washington, was not only a good teacher, but his many books on structural engineering, like Church's Mechanics, added greatly to the reputation of the college. Professor Ogden, the youngest of this pioneer group is still with us and as busy as ever. He is one of the best teachers of engineering that Cornell has had and his pioneer work in sanitary engineering and his long service to the state and city have also shed luster upon the college. There were others of course that gave of their knowledge and energy to build up the work in Civil Engineering, but these were the men responsible as we shall see for the high standards that have so long been a feature of the curriculum.

When Cornell was founded, there were no courses in Mechanical Engineering. Dr. Andrew D. White has remarked concerning the inauguration of courses in the mechanic arts, so called, "There was very little of useful example to guide us in what was then known as the 'mechanical side'; we were in fact among the pioneers and it should be said that Professor Morris with his practical knowledge, his devotion to his work and his warm feeling toward worthy students was of the greatest value in beginning the great development which we have since seen in Sibley College." For some time after the opening of the University, he was a dominating influence in the courses in mechanic arts. Nor was he interested in the practical side alone. The very valuable set of Reuleaux Models in the Department of Machine Design was purchased by him with money furnished by Miss Jennie McGraw, afterward Mrs. Fiske, in whose honor the Library was erected.

In 1873, Professor John E. Sweet joined the faculty as Director of the shops. While he remained only until 1879, he impressed himself very vividly, not only upon the work of the college, but upon the teaching of machine design to this day. He was a remarkable man in many ways and greatly beloved. His Straight Line steam engine was one of the significant products of the time.

In 1885 President White brought Robert Henry Thurston from Stevens Institute of Technology to be Director of Sibley College and thereby inaugurated a new era for Sibley College and for mechanical engineering in this country. Dr. Thurston was a remarkable man. A graduate of Brown University, the son of a well-known engine builder, he had seen service in the Navy during the Civil War, had taught five years at the Naval Aca-



IRVING POTTER CHURCH '73

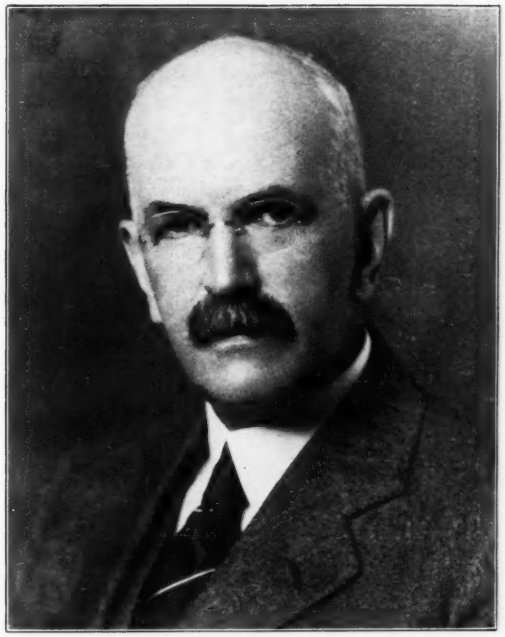
demy, and at the time he was called to Cornell he was Professor of Mechanical Engineering at Stevens. While there, he started a mechanical laboratory to give students actual experience in analyzing the characteristics of power machinery and other mechanisms. This was one of the first, if not the first laboratory of this kind and he brought the idea with him to Cornell. Thurston was a man of vision, a scholar, a voluminous writer, a born leader of teachers, one of the best known engineers and engineering educators of his time. He was the first president of the American Society of Mechanical Engineers. His influence on research and graduate study and his many contributions to the literature of engineering and many other topics were largely instrumental in establishing the great reputation of the college. To the students he was known as "Bobby", and his course in Thermodynamics as "Bobbyology", which speaks for itself about his kindliness and genial personality.

When Thurston came, the faculty consisted of Professor John L. Morris, Assistant Professor Frank H. Bailey, and Associate Professor E. C. Cleaves, who had charge of the Department of Art and Drawing.

Thurston immediately began to augment this group with strong men. The most important of his appointments and their periods of service were as follows:

Albert W. Smith	Machine Design	1887-1891
E. P. Roberts	Electrical Engineering	1888-1889
Harris J. Ryan	Electrical Engineering	1889-1905
Rolla C. Carpenter	Experimental Engineering	1890-1917
William F. Durand	Marine Engineering	1891-1904
John H. Barr	Machine Design	1891-1903
George R. McDermott	Naval Architecture	1892-1929
H. Wade Hibbard	Railway Engineering	1898-1904
Forrest R. Jones	Machine Design	1903-1905

Of this group, A. W. Smith, W. F. Durand, and Forrest R. Jones still survive. John H. Barr passed away in Ithaca, March 27, 1937, and G. R. McDermott on May 26, 1937. Professor Smith resides in Ithaca and Professor Durand at Stanford University. The appointment of E. P. Roberts is noteworthy, for though he stayed only one year, it marks the beginning of instruction in Electrical Engineering in this Country. Electrical Engineering was developed at Cornell by Harris J. Ryan and remained a part of Sibley College until the reorganization in 1920, when it was made an independent school. A. W. Smith went to Wisconsin in 1891 and thence to Stanford, returning to Cornell in 1904 as Director to make a great contribution to the College, for which he is both loved and honored. Professors Hibbard and Jones did not join the staff until near the end of Dr. Thurston's life. The group, therefore, that assisted Thurston most in developing the college were Ryan, Carpenter, Durand, Barr, and McDermott. Among the appointments of Thurston's later days there were three who were to share the responsibility of carrying on his work, namely, Herman Diederichs '97, appointed Instructor in Experimental engineering in 1897, William N. Barnard '97,



JOHN H. BARR '88

appointed Instructor in Machine Design in 1897, and Dexter S. Kimball, appointed Assistant Professor of Machine Design in 1898.

Ryan, Carpenter, Durand, Barr, and McDermott were all men of note in their day. Carpenter's work in developing experimental laboratory methods was of a pioneer nature, and his book on Experimental Engineering ranks with Church's Mechanics as a landmark in education. Durand today is one of the best known of men in engineering and scientific circles. Barr's work in Machine Design was also noteworthy. But it was the collective effort of this group led by Thurston that was most important. Ten years after Thurston took charge, or in 1895, the entrance requirements were pushed up to include four units of Mathematics and French or German in addition to the usual liberal requirements. This entrance requirement, which is practically the same as that now in force, is the highest that has ever been required for any undergraduate course in this country and has been attained by only a very few colleges, including the Massachussets Institute of Technology. The College of Civil Engineering also raised its entrance at this time to the same level, and if colleges of engineering in this country had followed the lead of Cornell's two colleges, the history of engineering education in the United States would have been somewhat different. Since that time Analytic Geometry and Calculus have been taught at Cornell in the Freshman year and Mechanics in the sophomore years. As this last lies at the root of all engineering, the courses at Cornell have been for many years from a term to a year in advance of all but a few institutions in this country. This elevation of the qual-

ity of instructions was one of the greatest services that the two faculties under Thurston and Fuertes conferred upon engineering education at Cornell.

Dr. Thurston died in 1902 and Director Fuertes in 1903. Their passing may be said to close the pioneer period of engineering education at Cornell. They were succeeded by Directors A. W. Smith and E. E. Haskell. Progress under these able leaders was of the nature of expansion and liberalizing of the curricula to meet new conditions. In 1920 the present College of Engineering was organized with its three schools of Civil Engineering, Mechanical Engineering, and Electrical Engineering, with Professor F. A. Barnes, H. Diederichs, and Alexander Gray as Directors and the writer as Dean. Director Barnes resigned his Directorship and was succeeded in 1935 by Director Hollister. Director Gray died in 1921 and was succeeded by Director Lincoln in 1922. The same policy of growth and liberalization has been followed throughout the years, and there is every reason to believe that the present faculty under Dean Diederichs will keep the College where it has so long stood among the leading institutions of its kind in this country.

The College of Engineering has many material needs. It always has and probably always will have these. It has never had an equipment of buildings and apparatus commensurate with its faculty and quality of instruction. This is a problem that the Board of Trustees must face at once if the College is to be kept in the front rank. It is true of course that equipment is, in a way, a secondary matter, but in modern times it is an essential aid to the only characteristics that can or ever have made a college famous, namely, great scholars, great teachers, earnest intelligent students, and the spirit of scientific enquiry. May this College that we all love so well, the foundations of which the pioneers laid with such wisdom, and to the structure of which so many fine men have given great devotion ever enjoy these priceless blessings

"Spirit of Wisdom like an altar dwelling
High o'er this darkling earth blest with little learning,
May thy enkindling ray 'round about these towers dwell
Lighting thy hills—Cornell."

DEXTER S. KIMBALL

Refrigeration with Water Vapor

By C. O. Mackey

Professor of Heat Power Engineering, Cornell University

Air conditioning, with the required cooling and dehumidifying of the air during the summer months, has been a large factor in the development of new systems of refrigeration and in the use of new refrigerants. With the mechanical compression systems of refrigeration, reciprocating, rotary, and centrifugal compressors are used. Although the methods of compression vary with the refrigerant selected, the rest of the refrigeration system is essentially the same. The refrigerant absorbs heat at a relatively low temperature and is vaporized; after compression to a higher pressure and temperature, the refrigerant vapor is condensed, usually by heat exchange to water or air or a combination of these two cooling fluids (evaporative condensers). The liquid refrigerant then passes through a valve which reduces the pressure and temperature of the refrigerant and also regulates its flow.

The properties of some common refrigerants are given in Table I.

Of these refrigerants, ammonia and methyl chloride form explosive mixtures with air in the right proportions. Note that three of these refrigerants, Freon 12, Freon 114, and water are regarded to be less toxic than carbon dioxide.

The performance of these refrigerants in an ideal refrigerating cycle, consisting of isentropic compression of vapor that is initially dry and saturated, constant pressure cooling and condensation, adiabatic throttling, and constant pressure evaporation, is given in Table 2. The piston displacement of the compressor per ton of refrigeration (cooling at the rate of 200 Btu. per min.), the pressure ratio of compression, and the horsepower per ton required to drive the ideal compressor are given for two conditions of operation—one for the standard temperatures of 5°F in the evaporator and 86°F condensing, and the other for temperatures more common in air conditioning, viz., 40°F in the evaporator and 90°F condensing.

For the same evaporator and condensing temperatures, there are no great differences of performance (CO_2 excepted) when expressed in terms of the power required to drive the ideal compressor per ton of refrigeration. The piston displacements of the ideal compressors per ton and the pressure ratios of compression are widely different, however.

TABLE I

Refrigerant	Chemical Formula	Molecular Weight	Other Names	Boiling Point, deg. F	Toxic Group *
Ammonia	NH_3	17.0		—28	2
Carbon Dioxide	CO_2	44.0		—109	5
Dichlorodifluoromethane	$C Cl_2 F_2$	120.9	Freon-12	—22	6
Dichlorotetrafluoroethane	$C_2 Cl_2 F_4$	170.9	Freon-114	+38	6
Methyl Chloride	$C H_3 Cl$	50.5		—11	4
Methylene Chloride	$C H_2 Cl_2$	84.9	Carrene No. 1	+104	4-5
Sulphur Dioxide	SO_2	64.1		+14	1
Trichloro mono-fluoromethane	$C Cl_3 F$	137.4	Freon-11 Carrene No. 2	+74	5
Water	H_2O	18.0		+212	6

* Classification by National Board of Fire Underwriters, Report No. 2375.

Group 1. Lethal or produce serious injury in concentrations of ½ to 1 % for durations of exposure of 5 min.

2. Lethal or produce serious injury in concentrations of ½ to 1 % for durations of exposure of 30 min.

3. Lethal or produce serious injury in concentrations of 2 to 2½ % for durations of exposure of 1 hr.

4. Lethal or produce serious injury in concentrations of 2 to 2½ % for durations of exposure of 2 hrs.

5. Much less toxic than Group 4 but more toxic than Group 6.

6. Do not appear to produce injury in concentrations up to 20% for exposures of 2 hrs.

TABLE II

	5°F to 86°F			40°F to 90°F		
Refrigerant	Piston Displ. cu. ft/ min/ton	Press. Ratio of Comp.	HP/ton	Piston Displ. cu. ft/ min/ton	Press. Ratio of Comp.	HP/ton
Ammonia	3.44	4.93	0.973	1.66	2.23	0.528
Carbon Dioxide	0.999	3.11	1.84			
Freon-12	5.81	4.07	1.00	2.93	2.21	0.550
Freon-11	37.0	6.17	0.955	15.6	2.80	0.521
Methyl Chloride	6.09	4.58	1.00	2.98	2.34	0.525
Carrene No.1	75.0	8.52	0.918	27.1	3.22	0.508
Sulphur Dioxide	9.24	5.63	1.00	4.07	2.63	0.514
Water				480	5.74	0.555

If chilled water instead of the expanded refrigerant be used in comfort cooling, there is some justification for using a 50°F. evaporator temperature for water when this refrigerant is compared with the others. For 50°F. to 90°F. with water vapor, the volume is 333 cu. ft. /min/ton, the pressure ratio of compression is 3.92, and the ideal unit requires 0.419 HP/ton.

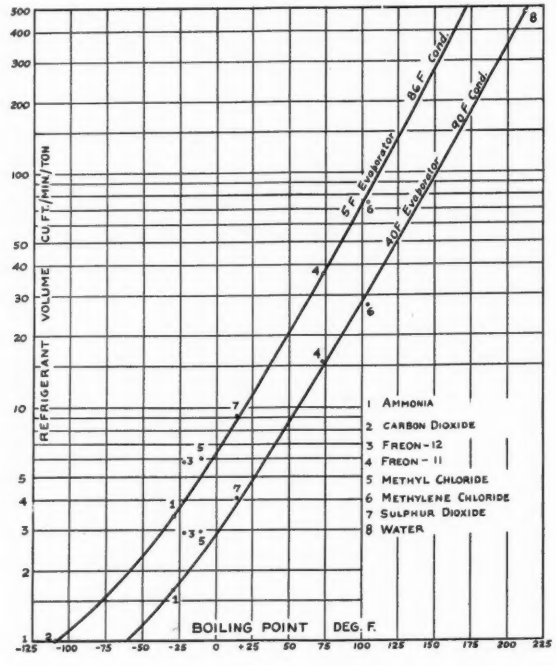


Fig. 1.

Fig. 1 is a plot of the piston displacement of the ideal compressor per ton of refrigeration vs. the boiling point of the refrigerant. Although the points for methyl chloride and freon-12 are off a smooth curve, the indication is clear enough. As the boiling point increases, the required piston displacement rapidly increases (log scale for ordinate). This curve might be used in predicting, roughly, this piston displacement for any new refrigerant when the boiling point is known without any other data on the enthalpies or volumes. As the boiling point increases, the pressure ratio of compression increases, although not as rapidly as the piston displacement.

The type of compressor to be used depends upon the volume of refrigerant to be handled per min. per ton or upon the boiling point of the refrigerant. Where this piston displacement is small, or the boiling point low (say less than 15°F), the reciprocating type of compressor is successfully used. The rotary compressor is commonly used for refrigerants that have boiling points below 70°F, and the cenrifugal machine is best adapted to refrigerants that have boiling points above 70°F. It is just as desirable to select a refrigerant with a large volume per min. per ton for centrifugal compression as to select one with a small volume per min. per ton for positive compression. It is not deemed commercially feasible to centrifugally compress much less than 1000 cu. ft. (end volume) per min. of any gas or vapor. This is not an absolute limit, but it may be used to estimate roughly what minimum tonnage might justify centrifugal compression with any of the listed refrigerants. For the air conditioning temperatures, there are only three of the listed refrigerants which should be commercially compressed centrifugally in capacities less than 250 tons—freon-11, methylene chloride, and water vapor. The optimum capacity for a centrifugal compressor may be reduced, of course, by a reduction in peripheral speed, but the number of stages of compression must then be increased to give the same compression ratio; this adds to the first cost of the low-capacity machine.

In the comfort cooling of large buildings, large capacities are required with moderate temperatures. The stage is therefore set for centrifugal compression. A non-toxic, non-explosive, non-inflammable refrigerant is desired. Although there are other refrigerants suitable for use in centrifugal machines, only water vapor will be discussed in the remainder of this article.

A complete unit of the centrifugal type consists of a compressor, flash type evaporator, vapor condenser, vacuum pump, and driver. The compressor may be driven by a steam turbine or by an electric motor through step-up gearing. Water from the condenser is sprayed into the evaporator; due to the low absolute pressure or high vacuum maintained therein, this water flashes into vapor. The heat of vaporization is supplied by the remainder of the water in the evaporator which is chilled in the process. The flash vapor is compressed and delivered to a condenser of the conventional multi-tubular type; the cycle is completed by the condensation of this vapor. The chilled water may then be pumped either to spray- or surface-type air coolers and dehumidifiers. A small motor-driven rotary vacuum pump is used to remove air and other non-condensible gases. Since the pressure in the evaporator and condenser is considerably less than atmospheric, any leakage is inward.

The centrifugal machine is commonly operated at constant speed, and reduced tonnage results in a decrease in the power required to drive; the power characteristic

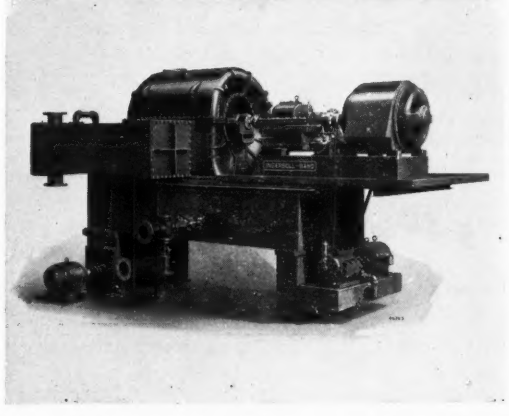


Fig. 2. Steam Jet Refrigeration Unit of 79 Ton Capacity Showing Condensers, Multiple Boosters, Pumps, and Evaporator.

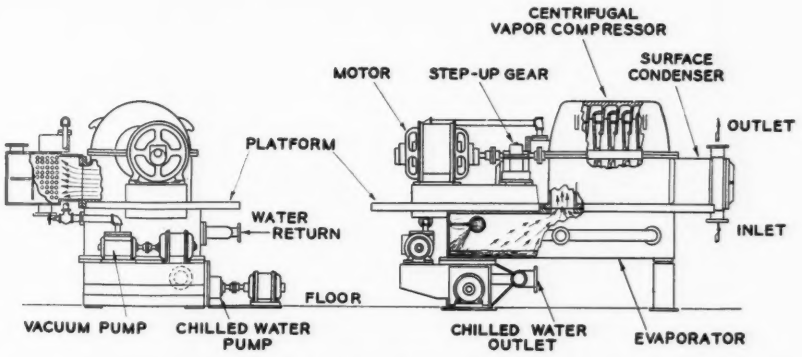


Fig. 3. Diagrammatic Sketch of Water Vapor Unit with Centrifugal Compression.

Water sprayed into the evaporator flashes into vapor by reason of the high vacuum maintained in that compartment. In vaporizing, heat is extracted from the water, which is thereby chilled. The vapor is compressed and is then delivered to a conventional tubular condenser.

is not unlike that of an electric generator—the unit floats on the load. At constant speed and with a constant quantity of condensing water, the temperature of the chilled water and the brake horsepower are nearly straight line functions of the refrigerating load. A constant temperature of chilled water may be obtained by mixing of chilled and by-passed water whenever this is necessary.

Steam ejectors may be used in place of centrifugal compressors for the compression of water vapor. Such units are sometimes called steam jet refrigerating units. The water to be cooled is sprayed into the evaporator. The evaporation of some of this water, under the low pressure in the evaporator, chills the remainder; the vapor is then compressed by the ejector action of the steam jet and is discharged to a condenser at a pressure that is sufficiently high to allow condensation by water at the temperature of the available supply. The loss by evaporation in the evaporator must be made up either from an outside source or by the return of condensate.

The operating characteristics of the steam jet system are unusual. The weight of water vapor that is compressed at a fixed suction pressure in a fixed booster is substantially constant regardless of the amount of steam used. Multiple boosters under hand or automatic control are therefore desirable to save steam under varying loads. A steam jet unit will have large reserve capacity for small increases in the temperature of the chilled water. At the same time, unpredicted high temperatures of the condensing water may cause a steam jet to entirely fail to function due to excessive back pressure. The steam jet booster may be unable even to compress the live steam through the higher pressure ratio of compression. An increase in the pressure of the steam supplied to the booster should be provided to give a reserve against failure or instability.

There is a large difference between the condensing water requirements of the steam jet and centrifugal water vapor systems because the quantity of heat that must be removed in the condenser serving the centrifugal compressor is the sum of the heat received by the water in the evaporator and the heat equivalent of the compressor work, while the condenser serving the steam jet system must condense not only the flash vapor from the evaporator but also the steam used in the booster. Since there are, roughly, three pounds of this motive steam per pound of flash vapor, the condensing water demands of the steam jet unit are greater than for a mechanical compressor system equally loaded.

Steam jet or centrifugal machines using water vapor as a refrigerant are not used to produce freezing temperatures. Chilled water temperatures between 45°F and 55°F are common, and these temperatures are sufficiently low to maintain the conditions required in comfort cooling.

The author is indebted to the Ingersoll-Rand Co., manufacturers of steam jet and water vapor centrifugal systems of refrigeration, for the engravings used in this article. References consulted by the author, and recommended articles for additional study follow:

"Water Vapor Refrigeration", by Paul Bancel, Vol. 30, Trans. A.I.Ch.E.

"Comparison of Thermodynamic Characteristics of Various Refrigerating Fluids", by W. H. Carrier and R. W. Waterfill, Refrigerating Engineering, June, 1924.

"Centrifugal Compression as Applied to Refrigeration", by W. H. Carrier, Refrigerating Engineering, February, 1926.

"Centrifugal Water Vapor Refrigeration", by A. D. Karr, Compressed Air Magazine, November, 1935.

"Heat Power Engineering", Part III, Barnard, Ellenwood & Hirshfeld.

Current A.S.R.E. Data Book.

Engravings Courtesy of Buffalo Sewer Authority

Removal of Interior Steel Arch Forms 11'-0" Semi-Elliptical Sewer Section

Buffalo Inspection Trip

By Geo. J. Kaye, C.E. '38

We came, we saw, we got drenched,—but we enjoyed every drop of it. In line with a new policy of the School of Civil Engineering, some fifty members of the junior and senior classes of that school, amply chaperoned by professorial reserve, made an inspection trip to the City of Buffalo on April 21 and 22, 1937. The purpose of the two-day visit was to obtain information for the new requirement of an accredited report on just such a trip—indeed a most desirable addition to the curriculum.

The cargo of engineers had hardly got over its spirit of revelry, so noticeable over the 150-odd miles of the Lehigh Valley bed, when it was packed into buses, and, after stopping at the Hotel Statler long enough to deposit all excess baggage, it was carried to the edge of the Niagara River and dumped—raincoats, notebooks, intellectual curiosity, and all—into the Buffalo Water Works.

At this point the intake at the head of the river and the 660 feet of 12-foot square rock tunnel which serve as a source of supply were described. We entered the $4,000,000 filtration plant, which consists of 40 filter units supplied with water from the intake by five low-lift, motor driven, centrifugal pumps of capacities varying from 15 to 75 million gallons per day. The water is distributed over the sand by overrunning central gutters in each filter bed. A net sand area of 1400 square feet is supplied, rated at 2 gallons per minute per square foot of sand area, and giving a rated capacity of 160 million gallons per day for the plant. There are two elevated tanks with a total capacity of 280,000 gallons of water to backwash the sand filters when such cleaning is found necessary as indicated by gauges on the control tables.

The water is passed from this plant to a coagulation basin, where it is kept for approximately three hours and treated with Aluminum Sulphate or "alum", subsequent to which the water is sterilized by the application of liquid chlorine.

Pumping Stations

When ready for distribution, the water is pumped to the city by the Colonel Francis G. Ward pumping station, which includes five 30 million gallons per day steam driven pumping units, and the Massachusetts Avenue station, which includes four similar units. These pumps were built by the Holly Manufacturing Company and all are of the Verticle Triple Expansion type. The pumps operate against a head of 225 feet and are supplied with 250 pounds of steam pressure by eight Babcock-Wilcox Boilers. In addition to the pumping units for the regular water supply, there are three Worthington pumps with a capacity of 300,000 gallons a minute at 300 pounds pressure, to be used for fire only. These fire units are two-stage centrifugal pumps and are driven by motors supplied with power from the Niagara Hudson Power Company.

Buffalo Sewer Authority

Lunch at the Hotel Statler was followed by a visit to the offices of the Buffalo Sewer Authority in City Hall, where Mr. Charles R. Velzy of the firm of Greeley and Hansen explained the general features of the sewer project now in construction. In laying down Buffalo's first sewer system engineers deemed it most practical to use the Buffalo River, Niagara River and Lake Erie as natural outlets for the sewage. These have long since become polluted and in 1912 the City of Buffalo began to attempt to remedy this evil. Delayed by the World War, tedious investigations, and the recent depression, it was not until June, 1935, that the Honorable George J. Zimmerman, Mayor of Buffalo, appointed the personnel of the Buffalo Sewer Authority. This Authority, under the able chairmanship of Mr. Daniel H. McCarriagher, set to work supplying ample finances for a $15,000,000 sewer project. The problem was solved by combining a grant of $6,750,000 from the United States Government through the Public Works Administration with funds raised by a bond issue of June 1936, as authorized by the State of New York under Chapter 349 of the Laws of 1935. The problem of choosing an engineer for so large a project was handled by interviewing and accepting offers from the leading firms of the country. The Authority finally awarded the contract to Greeley and Hansen, who are now in the midst of construction of the project, under the direction of Mr. Velzy as Resident Engineer.

When the project is completed, there will be more than 13 miles of intercepting sewer, varying in size from 24 inches to 11 feet 6 inches in internal diameter. There will also be about 4 miles of storm relief sewer in sizes from 42 inches to 12 feet. Some four miles of the project will be through tunnels, mostly rock. The depth of the sewers will vary from a few feet below the surface in the shallow points to a maximum of 80 feet below the surface in portions of the tunnel.

The afternoon of the 21st was spent in a tour of the various parts of the southern branch of the interceptor from the Bailey Avenue Bridge, across the Buffalo River, inward toward Bird Island, which is the site of the treatment plant now in construction. Our starting point was the upper end of the main interceptor, a 78-inch reinforced concrete pipe sewer in open cut. The sewage will then flow through first a 9-foot and then an 11-foot semi-elliptical reinforced concrete sewer. At this point trouble presented itself as the sewer had to be run through an earth tunnel at considerable depth. The plastic nature of the excavated material and the great depth of the tunnel combined to offer us an excellent view of true construction problems and the methods employed in handling them effectively. The shoring was of course very heavy, and the pick and shovel excavation necessitated by the shoring made progress in driving the tunnel both tedious and expensive. In the east heading of this tunnel the sewer section has been changed from semi-elliptical to an 11 foot circular section to facilitate construction in soft ground. This circular section flows into

(*Continued on page one hundred ninety-five*)

Construction of 11'-6" Semi-Elliptical Reinforced Concrete Sewer Section in the Bed of the Old Erie Canal.

Reading List for Junior Engineers

The Engineering Council for Professional Development has provided a most valuable aid to the cultural development of the junior engineer in preparing the Reading List we take pleasure in presenting below.

Two of the most important attributes the successful engineer must possess are first, the ability to deal with men and affairs and second, the ability to read and absorb the written experience of others. These abilities are seldom found fully developed in any man. Generally, they must be developed by the individual himself and usually after formal education is completed.

The Reading List given here, based upon recommendations by a number of eminent men, many of them distinguished engineers, is presented especially for the junior engineer who is desirous of broadening himself and developing a full professional life. The titles are, we hope, suggestive and will attract the reader and lead him to explore farther. It is expected that these subjects will provide the basic framework on which the non-technical culture of the engineer will be built.

NATURAL SCIENCE

BRAGG, WILLIAM. Concerning the Nature of Things. Harper, 1925.
A simple account, with many photographs, of the properties of atoms, and of the nature of gases, liquids, and crystals. Author is pioneer in X-ray work.

DAMPIER-WETHAM, W. C. History of Science and Its Relation to Philosophy and Religion. Macmillan, 1929.
Evolution of scientific thought and research from dawn of history in Babylonia and Egypt, through the speculations of Greece, and past the blind alleys of the Middle Ages to the present.

DARWIN, CHARLES. Origin of Species. Appleton, 1900.
The preservation of favored races in the struggle for life. Contains additions and corrections from the sixth and last English edition. Is not speculation, but evidence of what actually is.

DARWIN, C. G. New Conceptions of Matter. Macmillan, 1931.
Originally a series of lectures at Lowell Institute, Boston. Author is Tait Professor at University of Edinburgh. Book presents the broad features of the new theoretical physics in non-technical terms.

EDDINGTON, A. S. The Nature of the Physical World. Macmillan, 1928.
Takes up both relativity and the quantum theory and traces the effect of modern concepts on Free Will and Determinism.

HALDANE, J. S. Philosophical Basis of Biology. Doubleday, Doran, 1931.
Object of this volume is to present the theoretical basis of the nature of life which "biological observation seems to force upon us." Lectures were given under Donellen Foundation at Trinity College, Dublin.

JEANS, SIR JAMES. Mysterious Universe. Macmillan, 1932.
A discussion for the layman of our relation to the universe. Man's increased knowledge has resulted in a new formulation of this problem which has interested philosophers for thousands of years. Presentation is simple and lucid and, of course, authoritative.

KELLOG, VERNON. Human Life as the Biologist Sees It. Henry Holt, 1922.
For the layman. Interprets in simple language what science teaches about mankind in its relationship to origins, heredity, everyday life, death, the soul, and the future.

MERRIAM, J. C. The Living Past. Scribner, 1930.
A study of evolution from plant and animal life as indicated in footprints, bones, leaf imprints, skeletons, and other remains found in various parts of the country.

PEARSON, KARL. Grammar of Science. (London) A. & C. Black, Second edition, 1900.
Exposition of the meaning of scientific law. Interesting questions and analogies. Much destructive criticism of earlier scientists. This latest edition contains two new chapters: One on contingencies and correlations, and another on modern physical ideas.

PILCHER, R. B. and BUTLER-JONES, FRANK. What Industry Owes to Chemical Science. Van Nostrand, 1931.
A fine résumé of advances made in metallurgy and manufacture and various commodities and the applicaton of scientific research. Very readable and most compact and a convenient history of industrial chemistry.

RICKARD, T. A. Man and Metals. McGraw-Hill, Whittlesey House, 1932.
A history of mining in relation to the development of civilization from prehistoric times. The author is an authority and the book is full of information.

SHAPLEY, HARLOW. Flights from Chaos. McGraw-Hill, 1930.
The reader will find it valuable whether he knows little or much about astronomy. A good stretching exercise for the imagination.

THOMPSON, SIR J.A. Modern Science. Putnam, 1930.
The author discusses the question: Will the teachings of astronomy and science change our outlook on the universe as a whole, and the meaning of life? Book is valuable as means of provoking thought.

VAN LOON, H. W. Geography. Simon & Schuster, 1932.
Popular geography, emphasizing the human interest side of the world we live in. Discusses why we live where we do, where we came from, and what we are diong.

PHILOSOPHY, INCLUDING RELIGION

BROWNE, LEWIS. This Believing World. Macmillan, 1930.
A fascinating account of the development of the chief modern religions.

CABOT, R.C. Meaning of Right and Wrong. Macmillan, 1933.
Discussion of the characteristics of right and wrong conduct as related to ordinary human experience, for people unfamiliar with philosophy.

DEWEY, JOHN. Philosophy and Civilization. Minton, 1931.
Might be described as "essays in experimental psychology." Form is more readable than that of his earlier books.

ELLIS, HAVELOCK. Dance of Life. Houghton Mifflin, 1925.
Author's philosophy of life as an art. From a study of dancing as an essential and primary art, the theme is expanded through a consideration of the arts of thinking, writing, religion, and morals

HOCKING, W. E. Types of Philosophy. Scribner, 1929.
History of the leading types of philosophy, with thorough comparative analysis. Intended for beginners in philosophcal study.

JASTROW, JOSEPH. Effective Thinking. Simon & Schuster, 1931.
An informal account of thinking. Part I deals with the technique of thinking; part II with impediments to clear thinking; part III with constructive phases by which right thinking is guided and encouraged.

KEYSER, C. J. Humanism and Science. Columbia University Press, 1931.
Evaluation of science and mathematics as agencies for realizing the ideals of humanism.

SCHMIDT, NATHANIEL. The Coming Religion. Macmillan, 1930.
Survey of origin and development of religion to our times, and search for the direction in which religion is moving today. Author was Professor of Semitic Languages at Cornell.

STEPHEN, KARIN. Misuse of Mind. Harcourt, Brace, 1922.
This book likely to open one's mind to unexpected possibilities; an excellent introduction to the philosophy of Bergson.

THOMAS A KEMPIS. Imitation of Christ. Macmillan, 1924.
For five centuries the Christian manual. Expresses with simplicity the yearning of the devoted worshipper for communion with God and Christ. Offers ethical counsel and personal guidance and is an unfailing source of comfort and inspiration.

ECONOMICS AND SOCIOLOGY

CHASE, STUART. Mexico: A Study of the Two Americas. Macmillan, 1931.
A thought-provoking contrast between two civilizations—the one based on handcraft and the other on machines.

CHASE, STUART. The Paradox of Plenty.
A liberalist's view of our present economic situation.

COLE, G. D. H. Guide Through World Chaos. **Knopf, 1932.**
Survey of world crisis and its background of war conditions and in the light of capitalism of the past two centuries. Valuable material for discussion of communism and capitalism.

DAWSON, CARL and GETTYS, WARNER. Introduction to Sociology. Ronald Press, 1929.
Statement of fundamental sociological principles. Many concretely described social situations relating to urban life and economic activities.

FITCH, J. A. Causes of Industrial Unrest. Harper, 1924.
Judicial consideration of prevailing conditions and phenomena which cause and contribute to industrial unrest, but attempts no solution.

FLANDERS, RALPH E. Taming Our Machines. R. R. Smith, 1931.
Attainment of human values in a mechanized society. Written in popular manner; clear and simple. A fresh view of the world's present troubles.

HANSEN, A. H. Economic Stabilization in an Unbalanced World. Harcourt, Brace, 1931.
Treats: 1. International causes of instability; 2. Causes of world-wide unemployment; 3. Population stabilization; 4. Discussion of value of possible or desirable stabilized capitalism.

HUMPHREY, E. F. Economic History of the United States. Century, 1931.
Narrative of economic development of U. S., for purpose of discovering conditions of today from a record of country's growth

JACKS, L. P. Constructive Citizenship. Doubleday, Doran, 1928.
He has "brought into captivity many ideas which have waged solitary fight in isolated places, and has regimented them into such shape that they deal a smashing blow against mechanical schemes of social deliverance."

KELLER, A. G. Man's Rough Road. Yale University Press, 1932.
A study of age-old institutions—property, religion, and marriage, especially in primitive manifestations. Condensation of a four-volume work.

KEYNES, J. M. Essays in Persuasion. Harcourt, Brace, 1932.
Collection of prophecies covering the twelve years before 1932, on conditions in Europe and the U. S., which resulted from the Treaty of Paris, inflation and deflation, the gold standard, and a hasty review of political issues and the possibilitites of the future.

LYND, R. S. and MIDDLETOWN, H. M. A Study in Contemporary American Culture. Harcourt, Brace, 1929.
A painstakingly statistical, yet sympathetic appraisal of a typical small city.

MARX, KARL. Capital. Kerr, 1919.
A critique of political economy. Written originally to make plain the fallacy of capitalistic economy, and is still held to be the source from which anti-capitalistic movements draw their constructive power.

MILL, J. S. Principles of Political Economy, with Some of Their Applications to Social Philosophy. Appleton, 1898.
Abridged edition, with critical, bibliographical, and explanatory notes and a sketch of the history of political economy by J. L. Laughlin.

MILLS, F. C. Economic Tendencies in the United States. Little, Ives, 1932.
Statistical study from 1900 to 1929 of economic conditions.

PATTERSON, S. H. Readings in the History of Economic Thought. McGraw-Hill, 1932.
Selected readings omitting recent ideas. Arranged by schools of thought from times of earliest expositions of economics down to neo-classicism. Stresses minor rather than major orthodoxies.

SALTER, SIR ARTHUR. Recovery: The Second Effort. Century, 1932.
Analyzes the broad causes which have brought the world into the present state of distress, and indicates new requirements, economic, financial, and political, upon which to base a new world order.

SIEGFRIED, ANDRAE. America Comes of Age: A French Analysis. Harcourt, Brace, 1927.
Analysis, by a keen observer, of our ethnic, economic, and political situation. Displays extraordinary insight into the characteristics of American civilization.

SMITH, ADAM. Wealth of Nations. Putnam, 1904.
Inquiries into the nature and cause of wealth of nations. A land-mark in history of thought, but parts are now out of date.

SOULE, GEORGE. A Planned Society. Macmillan, 1932.
Critical analyses of our present unmanaged civilization, followed by an attempt to build up a case for economic planning. Informed and well-balanced discussion of need for a social plan.

PSYCHOLOGY

ACHILLES, P. S., et al. Psychology at Work. McGraw-Hill, 1932.
Material derived from a series of lectures arranged by the Psychological Corporation in 1931; gives a good idea of a few things being done today in the broad field of applied psychology.

ADAMS, SIR JOHN. Everyman's Psychology. Doubleday, 1929.
Book of applied psychology written in terms the layman can readily understand. Recent psychological tendencies and schools are presented, question of individual adjustment taken up, and studies of emotion and instinct as applied to individual development discussed.

EDMAN, IRWIN. Human Traits and Their Social Significance. Houghton Mifflin, 1920.
Introduction to contemporary civilization. Processes of human nature from man's simple inborn impulses and needs to their most complete fulfilment in relation to art, science, and morals.

ROBINSON, E. S. Man as Psychology Sees Him. Macmillan, 1932.
Man, and comments on his nature; psychology, its aims; a lucid exposition of what psychology is accomplishing in helping man to self-understanding.

SMITH, ELLIOTT DUNLAP. Psychology for Executives. Harper, 1934.
Deals wth themes such as habits and how to handle them, personality, self-control, and the effect of group psychology in industry.

VITELES, MORRIS. Industrial Psychology. W. W. Norton, 1932.
An attempt to present a comprehensive picture of modern industrial psychology in its applications, principally in Germany, France, England, Italy, etc., from its inception about twenty years ago, its problems, settings, findings, and accomplishments.

BUSINESS AND INDUSTRIAL MANAGEMENT

DAVIS, HOWARD L. The Young Man in Business. Wiley, 1932.
Simply written book on vocational guidance by a director of such activities in industry; of particular interest to young people.

DENNISON, HENRY. Organization Engineering. McGraw-Hill, 1931.
Well-written and shows original observation and analysis. Intended as an overall picture of the whole problem rather than as a discussion of specific situations. Intent is to en-

(*Continued on page one hundred ninety-six*)

EDITORIALS

DEDICATION

The march of the ages continues, and with the changing of the order it becomes our lot to assume the responsibility of publishing the CORNELL ENGINEER. We here and now pledge ourselves to the purpose of that publication. Born in the hardships of financial strain by the merging of the Sibley Journal of Engineering and the Cornell Civil Engineer, this publication stands not only as the record of engineering at Cornell, but as the most successful meeting ground and flux for the complete and flawless fusion of the several schools of engineering on the campus.

We shall of course strive faithfully to impart those efforts of Cornellians, scientific and other, in recent events of importance in the field of engineering. But we also sense the excellent opportunity that is ours in creating that perfect union so essential at the northern end of the quadrangle. Seventeen years after formal incorporation of the several engineering schools at Cornell into one College of Engineering, we still find, as will be acknowledged by those still familiar with Cornell activities, that brotherhood and mutual interplay of ideas among students and among departments in the Engineering College are lacking.

The American ideal of Union and its resulting strength has not found realization on our campus. Surely Civil, Electrical, and Mechanical Engineering are mutually dependent for life itself. Surely Cornell Engineers should not have their professional acquaintanceships within the limited horizon of their individual branches of the profession. We dedicate ourselves to the cause of union, and shall expend every energy and resource of this publication toward the consummation of that end.

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LIGHT STUDY

The three working conditions of paramount importance are light, warmth, and air. Of these, the one which is most strikingly out of proportion here at Cornell is light. Surveys prove our lighting facilities to be extremely poor, in fact dangerous, in many cases. When we are brought to the realization that since the founding of the University (sixty-nine years ago) lighting conditions on the campus have never been above 33% of the proper value (found to be the case through surveys by Junior Electrical Engineering and Hotel Administration students), it becomes evident that something must really be undertaken. But from the results of efforts put forth so far, it appears that it will take concerted action on the part of the entire student body to push through a remedial measure.

Willard Straight Hall, hub of the campus, and generally considered one of the most advanced buildings of its type, presents an excellent example of these terrible lighting conditions. Sadly enough, Willard Straight Hall also represents an average of those existing over the entire University. If figures still talk, perhaps the fact that the average illumination in the main study of Willard Straight is 1½ ft-candles, whereas a recognized minimum for hallways is 2 ft-candles, presents a suitable contrast here. A good practice standard is 12 ft-candles for a room of this type. The fixtures provided are pretty to look at, but are proven by their inefficiency to be meant for nothing more . . . At the entrance to the study there is a desk with ½ ft-candle of illumination. Sofas and chairs from which students read newspapers, are supplied with an average of 1 ft-candle of illumination, and the six partitions forming alcoves, serving also as stacks, hover around this same lighting value of 1 ft-candle. These represent a cross section of Cornell's lighting conditions, and they fall below a quarter of the recognized minimum illumination in every case.

In many of the main buildings of Sibley School, where a definite lighting level is extremely important, they are also exceedingly low. As compared with the necessary 20 ft-candles for illumination of classroom blackboards, the main lecture room blackboard of Franklin Hall, from which most engineering students take lecture notes, receives 2 ft-candles of illumination, seldom exceeding 5 ft-candles with the best of daylight. Here the ordinary black-white contrast has not proven sufficient for reading from back rows. The use of colored chalks has been resorted to and still the contrast is not enough . . . Computing rooms, which should have lighting of at least 30 ft-candles (Illuminating Engineering Society standard) are also lighted at a hallway lighting minimum.

One would certainly expect a drawing room to be the one place where correct lighting would be found, but East Sibley has its own figures to offer regarding this. Lighting on one desk near a window may have a range of illuminating values from over 100 ft-candles to as little as 10 ft-candles. Then too, the light through the windows comes at such angles as to add the problems of cross shadowing. On the other hand, tables on the sides opposite the windows are more evenly lighted, but are forced to rely almost entirely on artificial sources which average 2 ft-candles. A room of this type should be lighted with 30 ft-candles of fairly well distributed light.

Such are the conditions that exist throughout the University. It seems only fitting that the engineering college lead the way in the elimination of so definitely an engineering evil.

Do You Know These Men ?

PRESTON DAY CARTER

JOHN ALEXANDER MEADEN, JR.

The construction of "anything that floats on the Mississippi" will soon occupy the time of Preston Day Carter, '37 ME, who plans to enter the employ of one of the large contracting companies after graduation.

P.D., as he is known to his friends, graduated from Northwestern High School in Detroit where he was editor of the school annual, a member of the Student Council, the Debating Club, and the basketball team. After entering Cornell, his father's Alma Mater, he ran on the freshman cross-country team, then decided to enter two competitions simultaneously. Being successful in both competitions gave Carter, in his Senior year, the managership of Freshman Football and the position of Editor-in-Chief of THE CORNELL ENGINEER. In the capacity of editor of THE CORNELL ENGINEER, P. D. worked tirelessly to improve the quality of the publication. The new staff misses his capable guidance. As though running an athletic team and a magazine did not take enough of his time, P.D. has also been a member of the Freshman Advisory Committee, Frosh Cap Committee, President of his fraternity, Phi Sigma Kappa, Chairman of the 1937 Engineering Show, and a member of the A.S.M.E., Atmos, Scabbard and Blade, Quill and Dagger, and Tau Beta Pi.

A college education, in Carter's opinion, doesn't consist entirely or even for the most part in book learning, but rather in developing understanding, sympathy, and the ability to think clearly and straight and not to be overinfluenced.

Carter plans to stay in construction work for about two years and then return to college for graduate study in business administration, eventually working into production, a field in which his college experiences have made him intensely interested. We express our congratulations and best of luck for the brilliant career his activities at Cornell have promised.

At graduation this June, Cornell will lose one of its most outstanding trackmen in Captain John Alexander Meaden, Jr., '37 ME .Johnny entered Cornell from the High School at La Grange, Illinois, his home town, where his success in track was, according to his own admission, not particularly brilliant. When Johnny came under the tutelage of Coach Jack Moakley, his performance began to make amazing advances and in his first year, recognized as an outstanding middle distance runner, he was elected Captain of the Freshman Track Team. Since that time he has concentrated all his athletic abilities on track and cross-country, finally winning the Captaincy of the Varsity Track Team. His other activities include work on the Freshman Banquet Committee, Student Advisory Committee, Junior Prom Committee, Class Day Committee, and the '37 Memorial Fund Committeee. He is also a member of Aleph Semach, and Sphinx Head, and Treasurer of Spiked Shoe.

In moments of confidence, Johnny will reveal that one of his main purposes at Cornell is to have a good time; but don't mistake his meaning, Meaden gets his good times by working on committees, breaking records in track, and trying to make the most of the opportunities which Cornell offers.

After graduation Johnny expects to be employed by one of the larger motor truck manufacturers, eventually working up to a position in production engineering.

Meaden's hobby lies in short-wave radio. Before coming to Cornell he had been a licensed amateur operator, using an outfit which he built himself. His experiences in communicating with radio amateurs from coast to coast are interesting, especially his thrilling story of contacting a Berkeley, California, "ham" the night of their major earthquake. At Cornell, Johnny has put his best foot forward,—we're sure he'll make a splendid record in his field.

COLLEGE

ENGINEERS BALL

On Saturday night, May 8th, the Engineers with the help of a few socially inclined Architects and Arts students, who had recently been taking dancing lessons, packed the drill-hall to dance to the rhythm of Claude Hopkins and his associates. Thorough oiling of slide-rules preparatory to the dance made the affair a complete success both from an engineering standpoint and from a purely social standpoint.

E. E. SCHOOL

At the recent A.I.E.E. elections, the following men were made officers of the Student Section at Cornell for the year 1938-39:

Chairman, F. J. Skinner; Vice-Chairman, R. R. Bell; Secretary-Treasurer, C. E. Gruen.

At a meeting held May 22nd, the following Juniors were initiated into Eta Kappa Nu, honorary electrical engineering fraternity:

D. A. Kahn, W. A. Backus, F. J. Skinner, H. R. Kuppinger.

On May 15th the following men were initiated into the Delta Club, the social organization of the E. E. school:

D. F. Sanders, J. A. Smith, H. C. North, R. R. Bell, C. E. Gruen, W. H. Hall, P. E. Dittman, R. L. Kingsland.

On May 15th, the Cornell Student Branch of the American Institute of Electrical Engineers held its annual banquet at the Dutch Kitchen. P. M. Lincoln, Director of the E. E. School, presided as toastmaster. Associate Dean S. C. Hollister, Director of the C. E. School, was guest of honor. Speakers were A. C. Stevens, Vice-president of District One, and A. M. McCutcheon, National A.I.E.E. President. Mr. McCutcheon's topic was the fitting of electrical engineers for positions in life after leaving school.

C. E. SOCIETIES

At a meeting of the Pyramid Society held on Friday, April 23, the following men were elected to office for next year: Walter B. Kester, President; Jack W. Gaul, Vice President; and James E. Rasbach, Secretary-Treasurer; all of the Class of 1938.

In addition, Oliver D. Gildersleeve, Carleton T. Jones, Lee Rogers Kirk, William H. Scott, Joseph M. Steele 2nd, and John G. Tammen, all of the Class of 1939, were elected to membership.

At their April meeting, Rod and Bob Society elected the following members of the Class of 1939: Carl-Eric Beve, John F. Church, Harvey McChesney, Jr., Dudley A. Saunders and Matthew E. Torti.

Chi Epsilon held a dinner and special meeting at the Johnny Parsons Club on Tuesday, May 4, at which time the following men were elected to office for the forthcoming year: Richard S. Goodwin, President; Carl J. Browne, Vice President; Harmer A. Weeden, Secretary-Treasurer; and George J. Kaye, Corresponding Secretary, all of the Class of 1938.

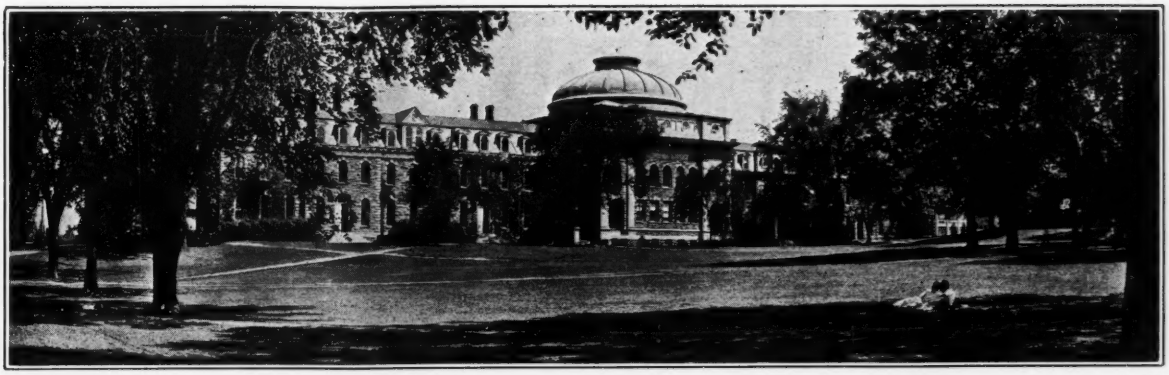
At the meeting of the A.S.C.E. held on May 4 the following officers were elected:

Jack W. Gaul, President; Robert M. Reindollar, Jr., Vice-President; Raymond N. Ali, Secretary; W. Bruce Kester, Treasurer.

Lieutenants Gregg and Carr who are taking graduate work at Cornell were the speakers. Lieut. Carr spoke on the life of an Army engineer, and Lieut. Gregg described a day at the U. S. Military Academy at West Point. Refreshments brought the meeting to a close.

ROD AND BOB HAMMERS PYRAMID

At one of the classics of the season played at Monkey Run on Sunday, May 23rd, Rod and Bob ended their winning streak of this season by a decisive victory over Pyramid in a contest lasting for 31 innings. Pitchers were Scotty Kirk for Pyramid and Bob George for Rod and Bob. At the associated beer-fest, Rod and Bob tied



NOTES

for first place with Pyramid with Rod and Bob, and Pyramid, runners-up for second place. Shutters and stretchers for disposal of casualties were provided by interested onlookers and relatives.

The Faculty
of the
School of Civil Engineering
Cordially Invites
All Cornell Civil Engineers
and their wives
to the
Fourteenth Annual
Civil Engineers Breakfast
Alumni Day, Saturday, June 19, 1937
8:00-10:30 A. M.
Sibley Recreation Room

APPLIED MECHANICS AND HYDRAULICS MEETING

The fifth National Applied Mechanics Meeting of the A.S.M.E., together with a meeting of the Hydraulics Division, will be held at Cornell on June 25 and 26. Preliminary plans include four sessions of the applied Mechanics Division, each session devoted to a general topic. The session on Elasticity is under the leadership of Professor S. Timoshenko; Fluid Mechanics, under Dr. H. L. Dryden; Plasticity, under Dr. A. Nadia; and Vibration under F. M. Lewis. Mr. C. R. Soderberg is the Chairman of the division. The Hydraulic Division sessions will be devoted to Cavitation under the direction of Mr. S. Logan Kerr, Chairman of the Division, and Mr. C. F. Merriam.

The social activities will include a picnic supper at Taughannock Falls State Park and a dinner at Willard Straight Hall.

An invitation to attend is also extended to members of the S.P.E.E. who might stop over on the way to the Cambridge meeting of that Society.

A.S.M.E. ELECTIONS

At the last meeting of the term, the A.S.M.E. elected the following men of the Class of 1938, to serve as officers for the coming school year: J. C. Antrim, President; Warren Jones, Vice President; and E. V. Dorr, Secretary-Treasurer.

Professor Ellenwood's term as Honorary Chairman has expired, and according to the rules of the Society, another faculty member must be chosen for that post. Mr. L. F. Welanetz, of the Mechanics Department, has been chosen by the student members. With the approval of the Society, he will become the new Honorary Chairman.

Following the elections, Mr. P. R. Sidler, the guest speaker of the evening, was introduced. Mr. Sidler, the American representative of Brown, Boveri & Company, Ltd., of Baden, Switzerland, addressed a large audience on the "Velox Steam Generator". This generator is a comparatively recent development in the power field. The first unit was put into commercial operation only four years ago, but since that time, there have been several installed in European plants. The Velox generator is not yet being manufactured in the United States, and to date, there is only one such unit in this country. However, plans are being made for production here.

"The name, 'Velox'," said Mr. Sidler, "means 'high velocity', and refers to the rapid flow of the combustion products." The steam generator was developed as a result of experiments on internal combusion turbines. It was found that, due to the extremely high gas velocities used in the experimental work, there was an unusually high rate of heat transfer.

Mr. Sidler said that the Velox Steam Generator is particularly suited for marine use, as it requires little space, is not costly of operation, has a moderate first cost, and does not call for as many operators as does a steam boiler. He described several plants where the unit is being employed. After the lecture, Mr. Sidler exhibited an ingenious model of a complete installation.

CORNELL SOCIETY *of* ENGINEERS

J. D. TULLER '09, PRESIDENT

WALKER L. CISLER '22, VICE PRESIDENT — ADAM C. DAVIES, JR. '15, VICE PRESIDENT

DAVID HARMON '31 RECORDING SECRETARY — JOHN P. SYME '26, SECRETARY AND TREASURER

"The objects of this Society are to promote the Welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Column

April 30, 1937

FELLOW ENGINEERS:

This annual letter from the President of the Cornell Society of Engineers is sent to each of the more than 14,000 Cornell engineers with the purpose of acquainting them with the activities of this Society. It is hoped that it may be instrumental in keeping active your interest in Cornell. Speaking both from actual experience and from observation, I believe that such an interest in Cornell will be of positive value to practically every alumnus. It will help you to keep in contact with old friends and make for you new ones; it will stimulate your interest in life and youth; it will provide a means whereby you can help the University and the Engineering College because, "The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni." In the words of my predecessor, "The Cornell Society of Engineers is not a technical society. It is one of human relationships centered around our common heritage."

MARCH MEETING

One of the most interesting meetings the Society has had was that held in New York recently at which the President-elect Dr. Edmund E. Day was present. At the conclusion of the dinner, he talked in an informal and intimate vein. Those present were greatly pleased by Dr. Day's talk because it indicated to them that he was sincerely interested in engineering and the Engineering College at Cornell. Dr. Day is a very friendly and human sort of person and his contacts up to the present time with those connected with the University have been such as to create a very general feeling that he will make an exceedingly good president for Cornell. Either before or after the dinner Dr. Day personally met most of those present.

PLACEMENT BUREAUS

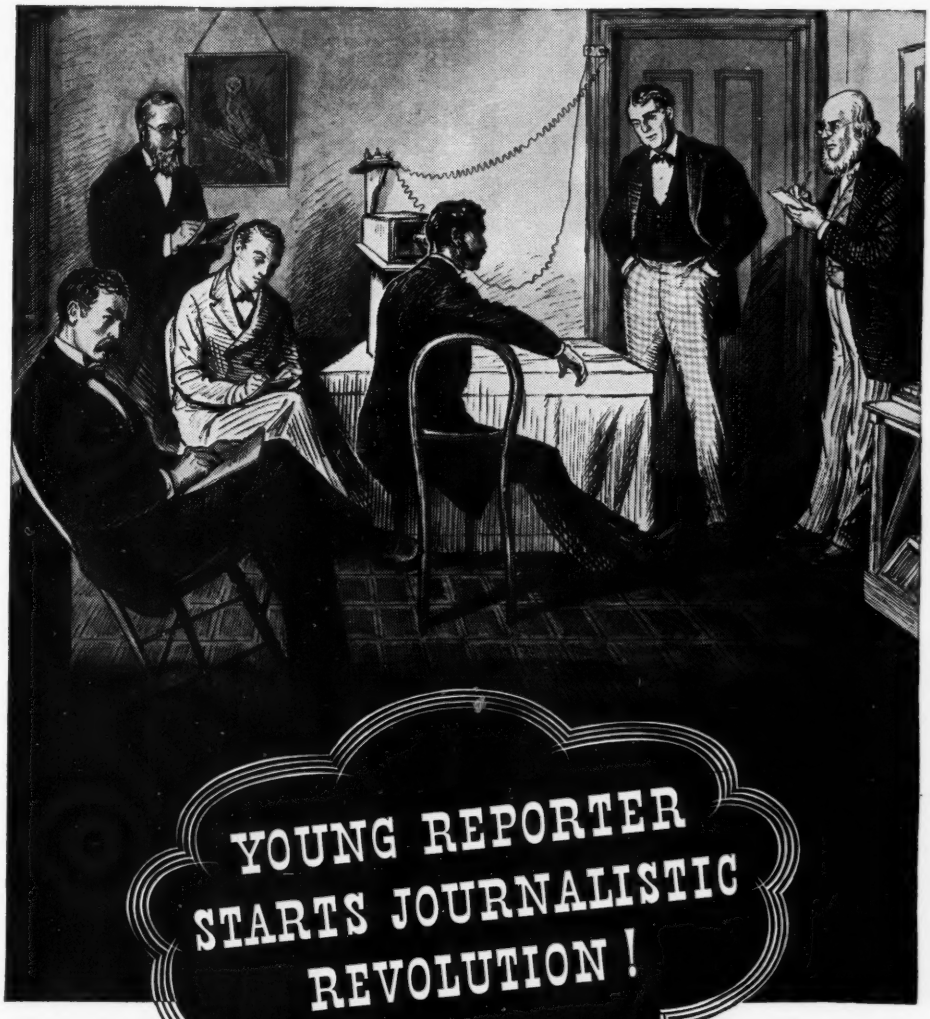
This Society is actively cooperating with the two placement bureaus maintained for Cornell alumni. Mr. Paul O. Reyneau '13, director of the Cornell Club Employment Service of New York, recently said, "It is well known that in any group of men, such as the one composed of Cornell Engineers, there always have been some in a type of work they are not best fitted to do—in jobs where the opportunities have been exhausted—in surroundings which are not congenial—in positions where ability and enthusiasm are given no chance to bear fruit. During the depression very little could be done to improve these situations; now with improved business conditions our placement offices welcome the opportunity of doing their part toward finding 'the right job for every Cornell Engineer'."

The University Placement Bureau functions from Willard Straight Hall in Ithaca. Herbert H. Williams '25 is director of this unit. He and Mr. Reyneau are in constant touch with each other and exchange information as to openings and registrants. The work has been divided in such a way as to get the most efficient results with the present facilities. These two officers are always ready to serve Cornell engineers. If you have an opening to fill, if you want a job or a change of association, consult with either of them. The general set-up is that the New York office serves the Metropolitan District while the Ithaca office handles the balance of the country.

The Placement Bureaus have given me the following for inclusion in this letter.

> "There seems to be little doubt that most of the seniors of 1937 in Electrical Engineering, Mechanical Engineering and Administrative Engineering will have secured jobs before leaving the University. Interviewers have been visiting the campus since November and have come in unusually large numbers since the beginning of the second term. The

(*Continued on page one hundred ninety-four*)



It happened in Salem, Mass., on February 12, 1877. The young reporter attended a demonstration of inventor Bell's new telephone—then "talked" his story to his paper in Boston *by telephone!*

Though he didn't realize it, he was inaugurating a new era in journalism. For today's newspapers could hardly exist without the telephone.

Gathering and spreading news with lightning speed is just one of the telephone's countless contributions to modern life. And 300,000 Bell System people strive constantly to make the service still better, still more useful.

BELL TELEPHONE SYSTEM

Why not telephone home oftener? Rates to most points are lowest after 7 P. M. and all day Sunday.

situation in regard to the 1937 Civil Engineers also is encouraging. Many of the large construction companies have advised that they expect to need recent graduates this summer.

"For the engineers who have had from two to ten years' experience there appear to be many interesting jobs available. For engineers of from ten to twenty years' experience the number of openings seems to be increasing. The opportunity for improving their situations by changes of associations into fields that are better suited to their abilities, therefore, exists for all these men. It is an excellent time to take stock of one's situation and to act to improve it if such a move is indicated. The Ithaca and the New York offices are ready to discuss these problems with any engineer who wants to do so.

"There also is an improvement in the employment situation of engineers with twenty or more years of experience. Evidence is accumulating to show that executive ability and mature judgment again are coming in demand, due to the death and retirement of executives, the increase in business activity and the fact that during the several years of the depression few subordinates have been trained to take the places of their superiors."

Regional Groups

During the past year, the movement to make this Society more truly national in scope has been carried forward under the able direction of John H. Lawrence, '09. I have asked him for a statement and he has submitted the following:

"In accordance with a program mapped out last year, regional sections have been or are being organized in various sections of the country. The following cities which have large groups of engineering alumni were selected to serve as the initial units: Boston, Philadelphia, Baltimore, Washington, Pittsburgh, Cleveland, Chicago, Milwaukee, St. Louis and Detroit.

"It is not our intention to try to emulate the national engineering societies by building up a large organization, as the dues charged would not permit. The idea is to encourage the alumni of the Engineering College to meet occasionally during the year to discuss the affairs of our college and incidentally renew the friendships of the days in Ithaca. There are many problems on which the alumni can be of assistance not only to the faculty of the Engineering College but also to the Trustees of the University. We desire to have the advice and counsel, not only of the engineers in New York, but of engineers throughout the country. Until the consolidation of the two college papers into the Cornell Engineer we had no means of contact with the alumni scattered throughout the various states. Now every member of this society receives the Cornell Engineer.

"Whether or not there is a section in your locality, get together with other alumni and discuss matters affecting the Engineering College. Let us have your views or write to Dean Diederichs. He is heartily in accord with the formaton of regional sections. With your assistance this organization can be of inestimable value to the Engineering College. If you are not a member, join now. The dues are only $2.00 per year, including a subscription to the Cornell Engineer."

In line with the policy of having the President of the Society come from outside the New York area, Mr. Gustav J. Requardt, '09, of Baltimore has been nominated for president for the ensuing year. The election of officers will be held at the annual meeting which occurs on Thursday evening May 6th in the quarters of the Cornell Club of New York. Under the new set-up, the affairs of the parent organization in New York City will be headed by an Executive Vice President, who will work in cooperation with the President of the Society. For this office Mr. Walker Cisler has been nominated. The other nominations are: for Secretary-Treasurer, John P. Syme '26; Corresponding Secretary, David Harmon '31.

Hutchinson '09 M.E. For Alumni Trustee

Contending that the area west of New York has an inadequate representation on the Board of Trustees, a group of Chicago alumni are actively working for the election of Alfred H. Hutchinson '09 M.E. of Chicago. The executive committee of the Cornell Society of Engineers, after careful consideration, has decided to endorse Mr. Hutchinson's candidacy. He is the only candidate who is an engineer. It is felt that we need engineers on the Board of Trustees at this time especially, because of the important matters concerning the Engineering College that will be presented for consideration within the next few years.

Mr. Hutchinson is President of the Continental Scale Company of Chicago. He has been active in Cornell affairs since graduation and was prominent in athletics while in Cornell, being a member of Varsity football and track teams. At the present time, he has two sons in the University.

The Cornell Engineer

The Cornell Engineer is the official organ of the Cornell Society of Engineers. A subscription to it is included with each membership. If you are a member of the Society and have not been receiving the paper regularly, I shall be glad to personally investigate the matter, if you will notify me.

During the past year there has been a marked improvement in this publication. Suggestions, articles for publication and items for inclusion in the column "Alumni Notes" will all be welcomed. They should be sent to Mr. G. J. Kaye, Editor-in-Chief, Lincoln Hall, Ithaca, N. Y.

In Conclusion

I urge you, if you are not already doing so, to support this Society in every way that you can. If you are not a member, join. If possible, become affiliated with one of the regional groups. I believe you will find an active interest in this Society and in alumni affairs to be of great value to yourself.

Yours for Cornell,

J. D. Tuller, '09

President

(*Continued from page one hundred eighty-five*)

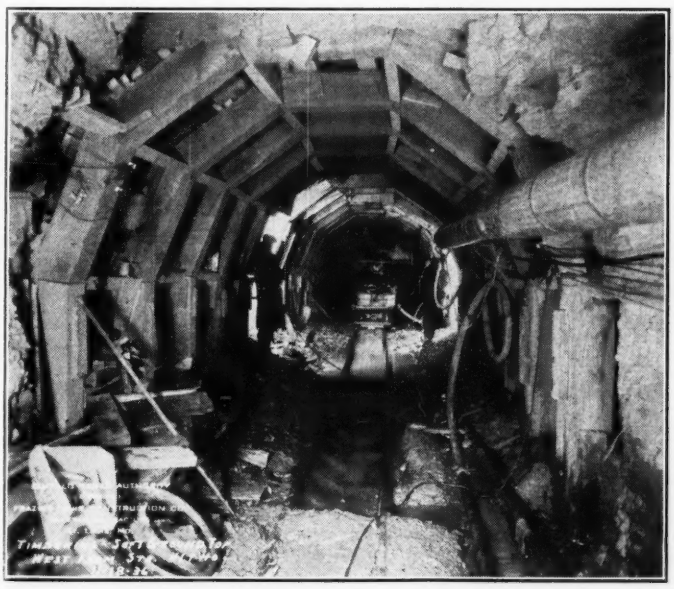
an 11½ foot semi-elliptical sewer in the bed of the old Erie canal. This section follows the canal for some 8,500 feet and, to permit construction, the contractor found it necessary to dewater the entire distance. The canal was dewatered by constructing a bulkhead at the north end of the work and pumping the water out of its bed.

The last section of the southern interceptor is a 9-foot horseshoe shape sewer of plain concrete, which will be poured in direct contact with the rock face. Operations here were not handicapped by any excessive water seepage, and the tunnelling proceeded at the rate of 25 feet per day. The tunnel was driven from two shafts and when holed through, the error in alignment was negligible. This section of the sewer is smaller in cross-sectional area, but the grade has been made much steeper and will carry the quantity of sewage supplied without difficulty. At Breckenridge and Niagara Streets this interceptor meets the northern interceptor, and both are conducted to the treatment plant through a rectangular tunnel under the harbor.

Bird Island Treatment Plant

The afternoon's activities were ended at Bird Island, where we were given a brief account of the proposed treatment plant by members of the engineering staff. The estimated cost of the plant is $4,000,000 and will include a number of tanks and buildings of large proportions. The main pumping station will be about 52 feet wide and 135 feet long, with portions of the structure extending some 40 feet into the ground, or approximately 30 feet below the level of the Niagara River. There will be 4 circular settling tanks 160 feet in diameter and 17 feet deep.

(*Continued on page one hundred ninety-seven*)



Engraving Courtesy of Buffalo Sewer Authority

Storm Relief Sewer Section with Soft Ground Overhead

CAMBRIDGE ELECTROMETERS

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Among the more prominent Electrometer uses are researches in radio-activity, spectroscopic investigations and many uses in conjunction with photoelectric measurements.

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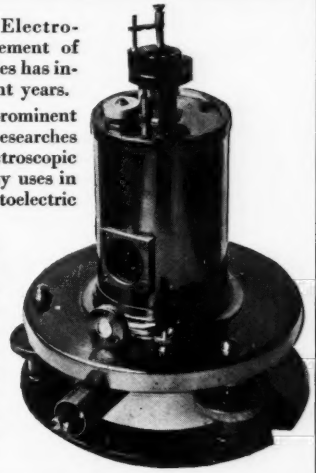

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Last Words

At this time, we wish to purchase from you instead of exhorting you to purchase from us. We want to buy your used books, drawing sets, slide rules, typewriters, etc. Bring them in any time.

On June 10th, 11th and 12th an out-of-town representative will be here to purchase any discontinued books which we cannot use. Remember the dates.

And now, best wishes for a successful summer and thanks for your patronage.

•

THE CORNELL CO-OP

Opposite Willard Straight

READING LIST

(*Continued from page one hundred eighty-seven*)

courage further systematic development of the art and science of organization engineering.

EIDMAN, F. L. Economic Control of Engineering and Manufacturing. McGraw-Hill, 1931.
Purpose of this book is to focus attention on economic aspects of engineering. It presents practical methods and techniques for solution of major industrial problems.

KIMBALL, DEXTER S. Principles of Industrial Organization. McGraw-Hill, 1933.
New edition fully revised and containing new material on such subjects as measures of management, mechanization of industry and factory arrangement, and production control.

METCALF, H. C. Business Leadership. Isaac Pitman, 1931.
A series of twenty-five lectures by various writers on biological, engineering, psychological, industrial, political, and educational problems of management.

SCHELL, E. H. Technique of Executive Control. McGraw-Hill, 1930.
Straight thinking applied to the duties and difficulties of the executive, with stimulating questions based on the problems presented.

TEAD, ORDAY. Human Nature and Management. McGraw-Hill, 1929.
Book is addressed primarily to the factory manager. Tells what psychology means, giving outline of mechanism of emotions habits, tendencies, and learning processes.

LITERATURE, INCLUDING POETRY, ESSAYS, AND FICTION

The mark of an educated man is a general familiarity with great literaure. The minimum for English-speaking people should be the Bible and Shakespeare. There are many other great writers and poets, and among them the young engineer will find a sympathetic spirit whose works will give him stimulus or repose as he wishes. Intimate acquaintance with a few of the world's great writers is to be desired and the following books are suggested as introductory only. A small library of great literature is a vital part of a busy man's relaxing equipment.

HOUSMAN, A. E. Name and Nature of Poetry. Macmillan, 1933.
A personal definition of its functions states that its aims must be to "transmit emotion—not to transmit thought." Nothing on modern poetry.

QUILLER-COUCH, SIR ARTHUR, edited by. Oxford Book of English Verse, Oxford University Press, 1910.

SHAKESPEARE, WILLIAM. Plays and Sonnets.

VAN DOREN, MARK, edited by. American Poets. Little, Brown, 1932. Selections from fifty-seven poets from 1630 to 1930.

CARLTON, W. N. C. English Literature. American Library Association, 1925. Reading with a Purpose Series.

HUBBELL, JAY B. Enjoyment of Literature. Macmillan, 1929.

LAMB, CHARLES. Essays of Elia.

PATER, WALTER. Marius the Epicurean.

PERRY, BLISS, edited by. Emerson's Journals. Houghton Mifflin, 1926.

SHEPARD, ODELL, edited by. Thoreau's Journals.

BRONTE, EMILY. Wuthering Heights.

BUCK, PEARL. The Good Earth.

BUTLER, SAMUEL. The Way of All Flesh.

CONRAD, JOSEPH. Lord Jim.

DICKENS, CHARLES. Tale of Two Cities.

DOSTOYEVSKY, FYODOR. Brothers Karamazov.

FIELDING, HENRY. The History of Tom Jones.

GALSWORTHY, JOHN. Forsyte Saga.

HAMSUN, KNUT. Growth of the Soil.

HARDY, THOMAS. Tess of the d'Urbervilles.

MALORY, SIR THOMAS. Morte d'Arthur.

ROLVAAG, O. E. Giants in the Earth.

STEVENSON, R. L. Treasure Island.

THACKERY, WILLIAM MAKEPEACE. Vanity Fair.

TOLSTOI, COUNT LEO. War and Peace.

UNDSET, SIGRID. Kristin Lavransdatter.

WHARTON, EDITH. Ethan Frome.

HISTORY

ADAMS, JAMES T. Epic of America. Little, Brown, 1931.
An inspiring narrative of the evolution of the American nation.

BEARD, C. A., edited by. Century of Progress. Harper, 1933.
A summary of outstanding events of the last one hundred years in American history.

BREASTED, J. H. Conquests of Civilization. Harper, 1926.
A summary of human progress from the crude beginning of civilization to the fall of Rome.

BRYCE, VISCOUNT JAMES. Modern Democracies, 2 vols. Macmillan, 1924.
Analytical summary of general prinicples of democracies as shown in France, Switzerland, Canada, United States, Australia, and New Zealand.

BUELL, R. L. Europe: A History of Ten Years (1918-1928). Macmillan, 1929.
An account of the drift of Europe during this time, by the research staff of the Foreign Policy Association. Traces history of Paris Peace Treaties and the internal development of leading countries, and attempts to interpret Bolshevism and Fascism.

CHAMBERLAIN, W. H. Soviet Russia. Little Brown, 1930.
Impartial interpretation of happenings in Russia during the seven years before 1930 during its transition from tsarism to communism. Gives historical background of the Revolution and its personalities and discusses the social leveling, cultural, and religious questions, and the woman movement.

HAYES, C. J. H. Historical Evolution of Modern Nationalism. R. R. Smith, 1931.
Discussion of nationalism as a political philosophy, formulated by leaders of thought and opinion, instead of a social process or a popular movement.

SULLIVAN, MARK. Our Times. Scribner, 1933.
History of America of the war years, with profusion of illustrations and quotations.

WELLS, H. G. Outline of History (New and Revised). Garden City Publishing Co., 1931.
A readable commentary on the life of man from the time of the Stone Age.

BIOGRAPHY AND TRAVEL

CHARNWOOD, LORD GODFREY. Abraham Lincoln. Henry Holt, 1916.

DANA, R. H. Two Years Before the Mast. Macmillan, 1923.

LENARD, PHILIPP. Great Men of Science. MacMillan, 1933.
Biographical sketches of about ten pages each, of more than fifty outstanding scientists from ancient times to the World War.

MACKENZIE, C. D. Alexander Graham Bell. Houghton Mifflin, 1928.

MEREZHKOVSKI, D. S. Romance of Leonardo da Vinci. Translated by Herbert Trench. Putnam.

PARKS, G. B., edited by. Travels of Marco Polo.

PROUT, HENRY G. Life of George Washington. Scribner, 1922.

PUPIN, MICHAEL. Immigrant to Inventor. Scribner, 1923.

STEFANSSON, VILHJALMUR. Northward Course of Empire. Macmillan, 1924.

STEFENS, LINCOLN. Autobiography of Lincoln Steffens. Harcourt, Brace, 1931.

THAYER, W. R. Life and Letters of John Hay: 2 vols. Houghton Mifflin, 191.

FINE ARTS

BUCK, PERCY. Scope of Music. Oxford University Press, 1924.
A series of ten lectures on physics of sound, origin, and place of music as an art, the nature of beauty, melody, form, and psychology of music.

BULLEY, M. H. Simple Guide to Pictures and Painting. Dutton, 1928.
Deals with principles of construction—design, personality, craft, tradition, and ways in which a painter works. Outlines the development of painting from Byzantine to modern French.

GARDNER, HELEN. Art Through the Ages. Harcourt, Brace, 1926.
World survey of history of art—architecture, painting, sculpture, and the minor arts from earliest times to the present.

HAMLIN, T. F. Enjoyment of Architecture. Scribner, 1921.
Fine explanations for laymen of basic principles of architectural design and construction, ancient and modern structures, with special attention to American buildings.

ISAACS, E. J. R., edited by. Theater. Little, Brown, 1927.
A collection of thirty essays on the art of the theater.

MOORE, DOUGLAS. Listening to Music. W. W. Norton, 1932.
Analysis, interpretation, and appreciation through intelligent listening. No previous training in music is required.

BUFFALO INSPECTION TRIP

(*Continued from page one hundred ninety-five*)

Combined Meeting

The contingent of Cornell undergraduates and professors was feted at the Cornell Club of Buffalo on the evening of the 21st. The event was a combined meeting of the local chapters of the Cornell Club and the American Society of Civil Engineers. A cordial welcome was extended to the group by the chairman of the meeting, Mr. Franklin Brown, who called on Professors Burroughs and Stanley to offer their impressions of the inspections of the day. The main speaker of the evening was Mr. Edgar Entwistle, manager of the Lackawanna plant of the Bethlehem Steel Company, following Colonel Mentis, who extended the greetings of the A.S.C.E., of which he is the President. Entwistle gave a most enlightening account of the makeup of the various departments of the Bethlehem Steel Company and offered valuable advice to young engineers interested in the steel industry. After partaking of a buffet lunch and beer, the group dispersed to find and make merriment at the multitude of interesting centers of amusement which are to be found profusely in the fair City of Buffalo.

Bethlehem Steel Plant

The morning of the 22nd found a sleepy lot of Cornellians being transported beyond the Buffalo limits to the steel plant at Lackawanna, at present the most productive of various plants of the Bethlehem Steel Company. A well planned and guided trip was made, in which the operations of the coking furnaces, the blast furnaces, and the open-hearth furnaces were displayed to advantage. These, together with the several rolling mills, offered a most interesting morning. The climax of the visit was supplied by a tour of the new strip mill and the fabricating plant where entire units of steel structures are cut to shape, drilled and assembled before shipment to the field.

Homeward Bound

A tired group of engineers finally boarded the train for Ithaca at 7:45. Tired, yes—but well satisfied in that they had had their vague conceptions of many problems of engineering transformed into more definite shape, even though so short a glimpse displayed but a minute part of that vast conglomerate of life's activities which forms the matrix of engineering. Hail to the faculty for their vision in planning so educational a student activity, and hail to Buffalo for her remarkable advancements and for her kind hospitality!

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ALUMNI NOTES

'91 ME—Herschel A. Benedict is retired from, but still associated with, the Public Service Corporation of East Orange, New Jersey, where his address is 38 Washington Terrace.

'91 CE—Clarence A. Snider has been elected president of the Sulphur Export Corporation with offices at 420 Lexington Ave, New York City.

'93 ME—Arthur W. Berresford, past president of the A.S.M.E., took part in a symposium commemorating the nintieth anniversary of the birth of George Westinghouse, at the recent annual meeting of the A.S.M.E. in New York City.

'96 ME—Ossian P. Ward, Secretary of the Kentucky chapter of the American Institute of Architects, is originating a movement to curb what is expected to be "the biggest building boom in history." Mr. Ward, in his recent report on "Housing a Nation from an Architect's Standpoint", warns against the financial losses which inevitably follow building "booms".

'97 ME—Lyndon B. Taylor is a cost analyist with the W.P.A. in Chicago, where he lives at 1752 Wilson Avenue.

'01 ME—Henry G. Macdonald is assistant secretary and assistant secretary to the vice president of the Pullman Standard Car Manufacturing Company, with offices at 52 Vanderbilt Avenue, New York City. He has two sons and a daughter.

'05 CE, '29 AB—Donald F. Stevens is general superintendent of transportation with the Baltimore and Ohio Railroad. He lives at Garden Apartments, Fortieth and Stony Run Lane, Baltimore, Mr. His son, John F. Stevens III, '29, is assistant trainmaster with the Baltimore and Ohio Railroad at Punxsutawney, Pennsylvania.

'05 ME, '34 AE—Samual A. Bingham is retired, and living at Tryon, N. C. His son, Samual, Jr., '34, is with the Taylor-Colquit Company, Spartanburg, S. C., and is living at the same address.

'07 ME—William R. Wigley has opened an office in the First National Bank Building in Ithaca for J. & W. Seligman & Co. of New York City.

'12 CE—Thomas W. Blinn is assistant engineer in the construction engineering department of the Detroit, Toledo, and Tronton Railroad, Dearborn, Michigan. He is "a full-fledged philatelist, and would welcome any Cornell alumni along that line." He has one son, and lives at 13288 Luader Avenue, Detroit, Mich.

'13 ME—Henry W. Lormer is works manager for the Willard Storage Battery Company, of Cleveland, Ohio. He has a twelve year old daughter, Barbara. His address is 1335 Oakridge Drive, Cleveland Heights.

'19 ME—Willard Hubbell, '19, is in the business of mortgage loans, and living on Route 1, Box 510, Miami, Florida. He reports having gone for a sail with Frank Steinrock, '18, and Frank Dunbar, '09.

'20 ME—Lawrence W. Breck is a salesman for the Patterson Sargent Company in Buffalo.

'20 ME—Arthur S. Whitmore is an engineer, and is living at 318 Grove Street, Montclair, N. J.

'25 ME—Robert R. Bridgman is chief of the time study department, Ford Motor Company, Buffalo assemly plant, Buffalo, N. Y. He lives at 190 South Creek Road, Hamburg, N. Y.

'25 MME—Dewar I. Niu is chief Mechanical Engineer of the Hui-Nan Railway, Chinese National Construction commission. His address is Hwai-Nan Railyway Administration, Kin-Lun-Kang, Pengpu, Anwhei, China.

'27 ME—Wallace O. Leonard has moved from Toledo, Ohio, to become zone manager for the Willys-Overland Motors, Inc., in the Southeast. He will be stationed at the Hotel De Soto in Savannah, Ga.

'24 CE—Newton Thomas is vice president of the Carbon Fuel Company of Charlestown, W. Va., where he is a member of the county welfare board. He has two sons and a daughter.

'34 ME, '34 AB—The marriage of Edward H. Beddeson and Barbara Wright took place in Summit, N. J., on January 2nd. He is with the publishing firm of John Wiley and Sons, Inc., in New York City.

'35 CE—Egon F. Brummerstedt is employed in the process equipment engineering division of Babcock and Wilcox Co. His address is 131 3rd Street, Barberton, Ohio.

'36 A.E., E.E. Mr. and Mrs. W. H. Matthies of Hackensack, New Jersey, have announced the engagement of their daughter, Miss Louise Matthies, '37, to Brian Chandler Bellows, Jr., '36, son of Mr. and Mrs. B. C. Bellows of Maplewood, New Jersey.

Miss Matthies, a student in the College of Home Economics, is a member of Delta Gamma sorority and the Glee Club. Mr. Bellows, who is a graduate of the College of Engineering, is a member of Zodiac fraternity and Eta Kappa Nu and Phi Kappa Phi, national honorary societies.

———o———

EDITOR'S NOTE:—'07, M.E. We regret that in our last issue it was erroneously reported that John W. Sheffer's daughter, Jean, was married to Walter D. Switzer '35. It is to be noted that the couple was recently engaged and as yet not married.

Stress and Strain

Temperance Lecturer: "And in conclusion, my dear fellow citizens, I will give you a practical demonstration of the evils of Demon Rum.

"I have two glasses here on the table: one is filled with water and the other with whiskey. I will now place an angle worm in the glass of water. See how it lives, squirms, vibrates with the very spark of life.

"Now I place a worm in the glass of whiskey. See how it curls up, writhes in agony, and then dies. Now, young man, what moral do you get from this story?"

Delt: "If you don't want worms, drink whiskey."

—*Rose Technic.*

"Daughter, there are two words I don't want to ever hear you use again. One of them's swell and the other's lousy."

"Yes, Mother, but what are the words?"

Cannibal King (rushing in): Gosh, am I late for dinner again?

Cannibal Queen: Rather! Everybody's eaten.

"Jimmy, I do wish you would learn better table manners; you're a regular little pig at the table."

Deep silence on Jimmy's part. So father, to impress him more, added, "I say, Jimmy, do you know what a pig is?"

"Yes, sir," replied Jimmy, meekly. "It's a hog's little boy."

Professor (in engineering economics class): "Preliminary expense is the money spent on your sweetheart, but after you've married it becomes fixed charges."

Bill Jones, applying for a lifeguard job:

Official: "Can you swim?"

Jones: "No, but I can wade to beat hell."

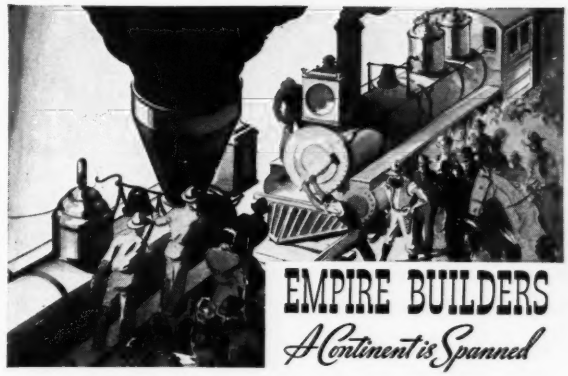
—*Illinois Technograph.*

The confident young man stopped in the apartment house hallway to call through the telephone. "Hello, baby," he said. "This is Gideon."

"There's so much noise on the line, I can scarcely hear you," came the voice of a gal on the other end of the wire. "Who did you say it was?"

"Gideon, honey. G for gin, I for ice, D for drinking, E for excitement, O for orey-eyed, and N for necking. Got that, honey?"

"Well," answered the gal, "not all of it, but come on up, anyhow."



When the transcontinental railroad became a reality in 1869, a new page was written in the history of this country, recording a forward stride destined immeasurably to hasten our industrial growth. R B & W —then twenty-five years old—was already supplying EMPIRE Brand Bolts, Nuts and Rivets for plant, structure and rolling stock.

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Index for Volume II

ARTICLES

Aerodynamics of Sails, The 101
Balance 'On The Wind' 156
Buffalo Inspection Trip 184
City Engineering in Ithaca 127
Diederichs, Dean Herman 5
Do You Want a Job? 84
German Technical Education 106
How Are Traffic Lights Regulated? 53
Instructional Organization of Engineering Pictured for Freshmen 7
Is the Working Man Safe? 33
My Experiences in the N.R.A. 29
Pioneers of the College of Engineering 177
Railroads Prepare for Speed 131
Refrigeration With Water Vapor 180
Resistance Welding 159
Smoke Abatement 153
Steel—A Modern Industrial Giant 107
Tapping and Trapping for Drinking Water 57
The Engineer and Social Science 35
This Business of Education 11
To Europe by Air 77
Trends in Engineering Education 125
Triborough Bridge 82
Your New Slide Rule 12

CONTRIBUTORS

Ashton, Herbert 53
Bangs, John R. 35
Benjamin, David 82, 159
Bissell, Nicol 156
Christy, Wm. G. 153
Cleary, S. F. 7
Diederichs, Herman 125
Eustance, H. W. 127
Evans, Frederic C. 33
Genung, C. E. 131
Hedberg, John 106
Hirshfield, C. F. 5
Hollister, S. C. 11
Jacoby, H. S. 29
Johns, W. H. 77
Kaye, G. J. 184
Kimball, D. S. 177
Mackey, C. O. 12, 180
Merker, Harvey M. 84
O'Connor, W. C. 101
Schlenker, Norman E. 57
Sullivan, A. H. 107

PERSONALITIES

Barton, John Titus 87
Carter, Preston Day 189
Christensen, Lawrence Alfred 111
Kunkle, Richard Warren 63
Macomber, Franklin Smith 111
Meaden, John Alexander, Jr. 189
Menges, Robert Henry 163
Peter, Wilbur Howard 137
Sampson, Fredrick Ford, Jr. 63
Serrell, John Jacob 137
Wandling, James Robert 163
Ware, James Richard 87

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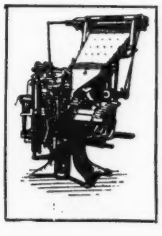

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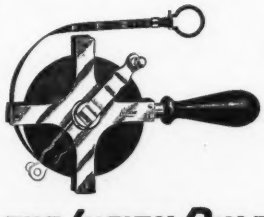

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G-E *Campus News*

FOR OUTSTANDING ACHIEVEMENT

February 26 was a big day in the lives of thirty-three G-E employees. These thirty-three were selected from the 60,000 persons in the Company's employ to receive the Charles A. Coffin Awards. There were fifteen factory men, twelve engineers, two commercial men, and four administrative and clerical employees. Twelve of the group are college graduates:

Roy T. Adolphson, University of Washington, '34; Eugene W. Boehne, Texas A & M, '26, and M. I. T., '28; Claude P. Hamilton, University of Nevada, '14; George H. Jump, Syracuse U., '10; Jack R. Meador, Texas A & M, '27 and '28; Harry E. Scarbrough, Georgia Tech., '19; Edward J. Schaefer, Johns Hopkins, '23; Alfred A. Thompson, University of California, '05; Carl Thumin, College of City of New York, '17, and M. I. T., '20; Harold E. Trekell, Kansas State, '31; Elmer J. Wade, University of Maine, '19; and Leo F. Worden, West Virginia University, '25.

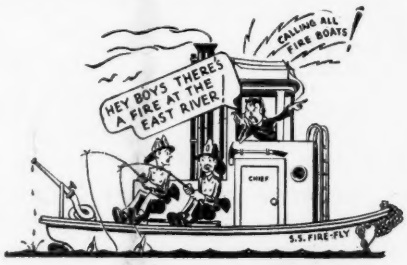
Each year General Electric makes these awards to employees who have done outstanding work, as provided in the Charles A. Coffin Foundation established in 1922. Charles A. Coffin was organizer and first president of General Electric.

"EXPERIMENTALLY—NOT ON PAPER"

Sixteen years or so ago, Dr. Willis R. Whitney, now Vice President in charge of General Electric research, sent a note to a research worker, suggesting experiments with a motor-generator set sealed gastight and filled with hydrogen to see if the machine ran cooler, and more efficiently. The results of those experiments promoted the use of hydrogen in synchronous condensers and established the present trend toward the use of hydrogen in turbine-generators.

Windage loss in a rotating machine is reduced about 90 per cent and noise is greatly decreased because of the low density of hydrogen. Heat is carried away much more rapidly through the higher thermal conductivity of hydrogen. Resistance to damage due to corona within the machine is increased. These characteristics increase the electrical output for a given core size and reduce inspection and maintenance expense.

The construction of several hydrogen-cooled turbine-generating units is now going on in the Schenectady turbine shop—perhaps all because of that note written by Dr. Whitney so many years ago.



CALLING ALL FIREBOATS

Fireboats are often away from their docks for several days at a time—not on a fishing trip, but fighting severe marine fires. The communication problem has been solved, however, for the fire-fighting sailors on the nine New York fireboats. General Electric engineers have installed a two-way radio system which will be in operation when the boats are out of telephonic contact with shore. This system will be an invaluable aid in expediting the handling of injured persons or those suffering from exposure.

In size, this system will be second only to the police-car system used in Boston. Two-way conversation will be possible, with no switching operations necessary to change from talking to listening. The equipment will include a remote-control, 500-watt, medium-frequency central transmitter for direct radio communication to all fireboats. The return part of the conversation from the boats will be transmitted by ultra-high-frequency radio to pickup receivers located at strategic points on the shore.

96-376DH

GENERAL ELECTRIC